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Construction Costs for Municipal Wastewater Treatment Plants 1973-1977

Dames and Moore, Denver, Colo

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Construction Costs for Municipal Wastewater Treatment Plants: 1973-1977

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Office of Water Program Operations,
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The three technical reports listed below were prepared in conjunction with the 1976 Update of Needs for Municipal Wastewater Treatment Facilities, a biennial report to the U.S. Congress. This series of reports provide construction cost relationships for wastewater treatment plants and sewers presently under construction and also related operations and maintenance (O&M) cost relationships for existing facilities. The data base for all three studies is representative of the ten regions.

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TECHNICAL REPORT

CONSTRUCTION COSTS FOR MUNICIPAL WASTEWATER TREATMENT PLANTS: 1973 - 1977

BY

DAMES & MOORE
WATER POLLUTION CONTROL ENGINEERING SERVICES
DENVER, COLORADO

JANUARY 1978

PREPARED FOR

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
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1.0 ACKNOWLEDGEMENTS

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This report was prepared by Dames & Moore, Water Pollution Control Engineering Services, Denver, Colorado, under the direction of Mr. James A. Chamblee of EPA Headquarters' Municipal Construction Division.

Sincere appreciation is extended to EPA Construction Grants personnel in each of the ten regions. Their advice and assistance was invaluable in accumulating the large quantity of construction bid data contained herein.

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2.0 SUMMARY

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The purposes of this study were to collect, categorize and analyze construction bid data for wastewater treatment plants nationwide with the goal of providing a reference for estimating future facility costs. To accomplish this, construction bid information was obtained from the construction grant files of each of the ten EPA Regional Offices. All facilities sampled are municipally owned treatment plants funded after 1973 under Public Law 92-500. The 536 treatment plant construction projects sampled included new, enlarged and upgraded facilities. Stabilization pond and aerated lagoon cost information was included along with that for mechanical plants. In addition to construction costs, data on Step I, Step II and the non-construction portion of Step III costs were collected and analyzed. Ineligible treatment costs and the costs of facilities for collecting and transporting sewage are not considered in this report. A parallel document with similar objectives has been developed for sanitary sewer facilities, and is entitled "Construction Costs for Municipal Wastewater Conveyance Systems: 1973-77", (EPA 430/9-77-014).

During data analysis, it was assumed that the cost of a treatment plant could be viewed from three perspectives: the cost of the entire plant, the sum of the costs of the individual unit processes, and the sum of the costs of individual construction components such as steel, concrete, etc. Therefore, construction cost data were categorized according to three levels of detail:

1. First Order - Total Plant Construction Costs
2. Second Order - Unit Process Construction Cost and Plant Construction Component Cost
3. Third Order - Construction Component Costs for Unit Processes

Using linear regression analysis techniques cost curves were developed relating item cost to plant design flow for each order of data. Methods of estimating wastewater treatment plant costs based on first and second order cost curves are presented. All data used in this report were updated from the bid date to second quarter 1977 dollars using the EPA Wastewater Treatment Plant Cost Indices.

In several cases insufficient data were available to develop valid cost relationships for specific unit processes or construction components. In other cases adequate data were available to define cost relationships for individual EPA regions for certain types of plants. As more construction cost history becomes available, it is expected that the current data base will be expanded and updated regularly providing a more complete series of cost estimating relationships.

3.0 INTRODUCTION

3.0 INTRODUCTION

3.1 Background

The United States Environmental Protection Agency and its predecessor agencies have been providing financial aid to local municipalities for wastewater treatment facility construction since 1957. In the twenty years of these grants programs several thousand facilities have been constructed, enlarged, or upgraded. Under the authority of the Water Pollution Control Act Amendments of 1972 (PL 92-500), this effort intensified as the EPA set out to achieve the goals of that act, including:

1. "That the discharge of pollutants into the navigable water be eliminated by 1985."
2. "That wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

Under PL 92-500, collector sewers became grant eligible for the first time and EPA grant assistance increased from 50 to 75 percent for treatment plants. More importantly, funds allocated to water pollution control increased substantially under the act as shown in the following table:

PL 92-500 OBLIGATIONS
(Federal Share)

Fiscal Year Ending	Dollars Obligated
6/30/73	$ 1,591,000,000
6/30/74	1,384,000,000
6/30/75	3,616,000,000
9/30/76	4,809,000,000
9/30/77	6,669,000,000
Total to 9/30/77	$18,069,000,000

In total, 18 billion dollars have been obligated to date in funding over 11,000 treatment plant and sewer facilities under PL 92-500. The increase in level of effort evidenced by this allocation is tremendous when compared to the 6.1 billion dollars funded between 1961 and 1972 under previous programs. Recent proposals to commit 45 billion dollars in Federal Funds to this effort over the next ten years indicate the program will continue growing.

3.2 Study Objectives

The increased intensity and volume of construction work underway since the passage of PL 92-500 has combined with general inflationary economic trends to cause a sharp rise in wastewater treatment facility construction costs. Tracking these price trends is difficult since many factors which are difficult to predict, like material and labor cost, affect the final cost of any facility. However, in order to control and project expenditures, the EPA must have access to accurate cost estimating techniques and objective criteria for future allocations of pollution control money.

While cost estimating models for wastewater treatment plants are available, they are generally based in design theory and useful only when comparing the cost of two or more different treatment systems. In general, they do not attempt to use the type of construction cost data collected in this study or make complete estimates of a particular facility.

This study, using data on the cost of constructing wastewater treatment facilities in the recent past, attempts to establish an empirical base from which future costs can be estimated using the assumption that past costs can be adjusted for inflation, material and labor cost fluctuations and various other influences to yield an estimate of what similar facilities will cost in the future. These estimating procedures are intended to be sufficiently simple and accurate that they can be applied to EPA's future cost estimating needs, including:

1. Step I (Facilities Planning) Cost Effective Analysis Requirements
2. Step II (Plans and Specifications) Design Cost Guidelines

3. Biennial Needs Survey Cost Estimating Requirements, as required by PL 92-500

4. 208 Areawide Planning, Cost Effectiveness Analysis Requirements.

3.3 Additional Benefits

While EPA's cost estimating needs provide the main impetus for this study, there appear to be other important benefits in related fields, including those outlined below. An attempt has been made to direct this document to each of these audiences to the extent possible.

3.3.1 Input to CAPDET Model

Concurrent with this study, the EPA and the U.S. Army Corps of Engineers launched a joint effort to refine the Corps' existing CAPDET Model (Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems). The updated CAPDET will attempt to estimate the capital costs for wastewater treatment plants within a ±10 percent range. By performing detailed designs of unit processes, calculating construction labor and material quantities and applying unit prices to these take-offs, cost estimates will be produced. It is anticipated that the present study will provide empirical check points for CAPDET estimates and also furnish non-construction costs essential for complete estimates.

3.3.2 State Pollution Control Construction Programs

Many states operate construction grant programs which are an integral part of the federal program and growing just as rapidly. The construction cost tabulations as found in this study could help personnel in these programs estimate future costs.

3.3.3 Index of Inflation/Deflation Effects

Collection of construction cost data nationwide will help quantify regional variations in material and labor prices and pin down temporal fluctuations in costs due to inflation, allowing more accurate predictions of future costs.

3.3.4 Planning Agencies at Local and Regional Levels

At the initial stage of project planning, cost of previous construction in a usable format would provide a beneficial tool, if not the only tool, for cost estimates by local and regional planners.

3.3.5 Citizen Participation

A section of the data presented in this study is intended to provide interested citizens with a simple method of estimating the cost and potential tax burden of proposed treatment works. Section 7.0 presents simplified cost estimating procedures with examples of their use for those interested in general treatment plant construction costs.

3.4. Previous Studies

To date, there have been relatively few attempts to systematize data and procedures on a national scale to develop construction cost estimating models for wastewater treatment plants. Three of the more familiar systems previously developed are reviewed below. While similar in purpose they vary significantly in technique.

3.4.1 Guides System

This technical report, published by the EPA in 1975 under the title "A Guide to the Selection of Cost - Effective Wastewater Treatment Systems", presents a user-oriented model in which treatment plant construction costs are estimated by combining costs of component unit processes. In developing the guides cost curves, processes were designed for plant sizes of 1, 5, 20 and 100 million gallons per day (MGD). Curves for each unit process were then drawn using these four points. Amortized capital construction costs from the unit process curves were combined with yearly operations and maintenance costs to allow comparative analysis of various process trains producing the required effluent quality. The report's purpose is clear, "This publication is not intended as a design manual but as an effective means for making preliminary cost comparisons based on the assumptions set forth in this report". (Pg. I-2). An important assumption of the report results in the exclusion of costs for ultimate sludge disposal, yardwork, pump stations, outfalls, garages, administration buildings and laboratories since, "Inclusion of such common costs is not necessary since the focus of this study is primarily the comparison of alternative wastewater treatment and sludge handling systems." (Pg. III-4).

3.4.2 CAPDET Model

The original CAPDET Model developed by the Corps of Engineers was based on parametric cost curves which related total unit process cost to specific design parameters such as overflow rates for clarification units. Since many other factors are involved in the determination of unit process cost, the accuracy of the original model is limited. In addition, cost indexing or updating was difficult. Due to these factors it was decided to upgrade the existing CAPDET model to allow more specific design data input and more ease in updating unit cost data. In many respects, the refined CAPDET Model will be similar to the Guides System, combining current cost data for such items as concrete, steel, chemicals and labor with quantities developed based on detailed unit process design. In contrast to the Guides Model, however, CAPDET will have the capability of calculating unit process material and labor quantities for the specific capacity required. Operation and maintenance costs will be factored into the total cost to provide criteria for process selection. Also in contrast to the Guides System, CAPDET will include all significant costs associated with treatment plant construction.

3.4.3 MCD-22 (EPA 430/9-76-002)

Entitled, "An Analysis [illegible] Construction Cost Experience for Wastewater Treatment Plants," MCD-22 involved collecting, categorizing and analyzing construction bid data generated by PL 92-500 activities in each of the ten EPA Regional Offices. The prime purpose of this work was to generate cost curves for the 1976 Needs Survey. A secondary goal of MCD-22 was to define the relationship between plant capacity, performance and cost parameters resulting from actual project data and to benchmark the Guides System cost estimates against these empirical relationships. The MCD-22 data base consisted of 157 projects from across the nation including new facilities and enlarged and/or upgraded facilities. Analysis of this data provided linear cost relationships of total project cost versus design flow for new construction and facilities upgrades. There was no attempt in the MCD-22 effort to collect or analyze unit process costs. It should be noted that while it accomplished its' purposes, this report was abbreviated in scope due to resource limitations.

3.4.4 Cost Estimating Technique Classifications

Two distinct types of plant cost estimating approaches can be identified. The first type may be termed the "theoretical" approach and basically combines design quantities and current unit costs such as the cost of steel or concrete to estimate what a plant should cost before construction. The second, or "empirical" approach, develops cost relationships based on what similar plants have cost in the past. CAPDET and the Guides System fall into the first category, while MCD-22 is an example of the second.

By nature the theoretical approach has the potential of better defining a specific treatment facility since detailed design parameters and unit prices are input. While this explicit, detailed input infers that resultant cost estimates are correspondingly accurate, it should be realized that several important variables are sometimes not quantified by theoretical systems. Among these are such items as (U. S. Environmental Protection Agency , MCD-22):

1. Competition in the contractor and supplier marketplaces.
2. Unpredictable variations in local material and labor costs.
3. Timeliness of construction.
4. Variations in conventional engineering, design and construction practices.
5. Design requirements imposed by regulatory agencies.
6. Degree to which cost is considered in design and construction phases.
7. Variations in site conditions.

The effect of such variables on cost can usually be quantified only after a construction contract is signed. The empirical system, while not defining the effects of each of these subjective factors individually, does testify to the cumulative effect of these factors on final construction costs. Obviously, each project is unique and the cumulative effects of the above listed factors vary from facility to facility. Because of this variation, cost analysis must utilize average conditions for these subjective parameters.

Using past construction cost information to predict future costs in an empirical approach hinges on the ability to place each sample treatment plant in a precise category of similar plants. This classification can be by design flow, unit processes employed, level of treatment, location or any combination thereof. There must also be sufficient data to define average cost relationships for particular classifications and, as with any cost estimating tool, there must be an earnest attempt to predict changes in cost parameters and quantify the effect of these changes on treatment plant construction costs. Unforeseen technological development or other factors could significantly affect the accuracy of empirical estimates and therefore the empirical base must be continually reassessed.

3.5 Data Base Updates

It is the EPA's intention to update cost data on a regular basis subsequent to this initial study, thus creating a "construction cost history" for wastewater treatment and conveyance systems. EPA funding of new municipal projects should yield a quantity and quality of bid data sufficient for this purpose.

3.6 Future Applications

It is not anticipated that estimates based on previous comparable construction can replace engineers' estimates or stand alone with respect to other cost estimating systems. However, the resource of construction cost history must be a major consideration in economic planning efforts. As this tool is fully developed and refined based on accumulation of cost experience, it should become complementary to and supportive of models such as CAPDET or the Guides System. Also, as a benchmarking tool it should serve to illuminate significant disparities in cost estimates for wastewater treatment plants and lead to rationalization of these differences.

4.0 SCOPE OF STUDY

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4.1 Public Law 92-500 Facilities

This study was limited to projects approved and funded under PL 92-500. Projects funded under this law are all recently bid allowing three advantages. First, recent construction costs minimize the effects of technological advancements and regulatory revisions on resultant cost relationships. Second, the accuracy of indexing costs to a current base dollar increases with more recent data. Third, the effect that the law itself has had on construction costs is effectively discounted.

4.2 Sample Selection

Because of the large number of grants issued under PL 92-500 and the tremendous amount of resultant cost information, coupled with limited EPA resources, it was not feasible to review all recently constructed, facilities nationwide. Thus, statistical analyses were performed using EPA Grants Information Control System (GICS) data to select a statistically adequate sample.

In brief, construction bids were studied for 536 treatment facilities ranging from less than 20,000 gallons per day capacity to over 300 million gallons per day capacity. The data base includes 270 secondary plants and 267 advanced wastewater treatment (AWT) plants. Of these, 225 are newly constructed plants, 38 are enlargements, 42 are upgrades, and 192 are enlarged and upgraded facilities. For the purpose of this study, enlargement is defined as the increase of treatment capacity (design flow) without change in the level of treatment provided. Upgrading means increasing the level of treatment provided while holding the plant capacity constant. Tabulations of facilities by type, size, treatment level, regional distribution, and other parameters resulting from this analysis appear in Appendix B.

Once the smaple size and distribution within EPA regions were determined, data collection efforts focused on obtaining a representative sampling from each EPA region with projects from each state, and geographical area including plants located inside and outside of Standard Metropolitan Statistical Areas (SMSA's). Since PL 92-500 usually requires secondary levels of treatment as a minimum, data were only collected from projects meeting or exceeding this requirement.

4.3 Non-Construction Cost Data

The normal procedure for allotment of water pollution control funds under PL 92-500 to eligible communities encompasses three "steps". The Step I phase includes facility planning, general cost-effective analysis and preliminary plant design. Step II funds provide for preparation of detailed plans and specifications for the chosen alternative while Step III moneys are allotted for actual plant construction.

This study provided for the collection of non-construction cost data including the non-construction portion of Step III costs such as administrative, fiscal, legal, engineering and land acquisition. Step I and Step II grant cost and other significant items were also accumulated. Again, it should be remembered that only grant eligible cost items were considered.

4.4 Sewers and Pump Stations

As mentioned previously, a parallel document, "Construction Costs for Municipal Wastewater Conveyance Systems: 1973-1977", analyzes construction cost data for gravity sewers, pump stations, force mains and associated appurtenances. Information on sanitary sewer construction costs is not contained in this report.

5.0 DATA COLLECTION AND CLASSIFICATION

5.0 DATA COLLECTION AND CLASSIFICATION

5.1 Preliminary Survey

Prior to extensive collection of facility cost information, a preliminary survey of available construction bid data was performed. This survey investigated municipal and state construction files as well as those in EPA regional offices. It was found that EPA grant files provided the most consistent and detailed cost information and, therefore, they were selected as the prime source of construction bid information.

5.2 Data Categories

This survey and previous experience indicated construction bid data for treatment plants are reported in four basic categories:

1. Total Construction Costs - Plants
2. Total Construction Costs - Unit Processes
3. Construction Components - Plants
4. Construction Components - Unit Processes

For the purposes of this study the four categories were defined as 1st, 2nd or 3rd order data with categories 2 and 3 combined as 2nd order data. Categories 1 and 4 correspond to first and third order costs, respectively. Second order data include unit process costs bid as one item and plant construction components. Generally, 3rd order data occurred in the form of costs for construction components for specific unit processes. An example would be the cost of concrete for the aeration basins in an activated sludge plant. Figure 5.1 illustrates the relationship between the three orders of data.

5.3 Data Collection Forms

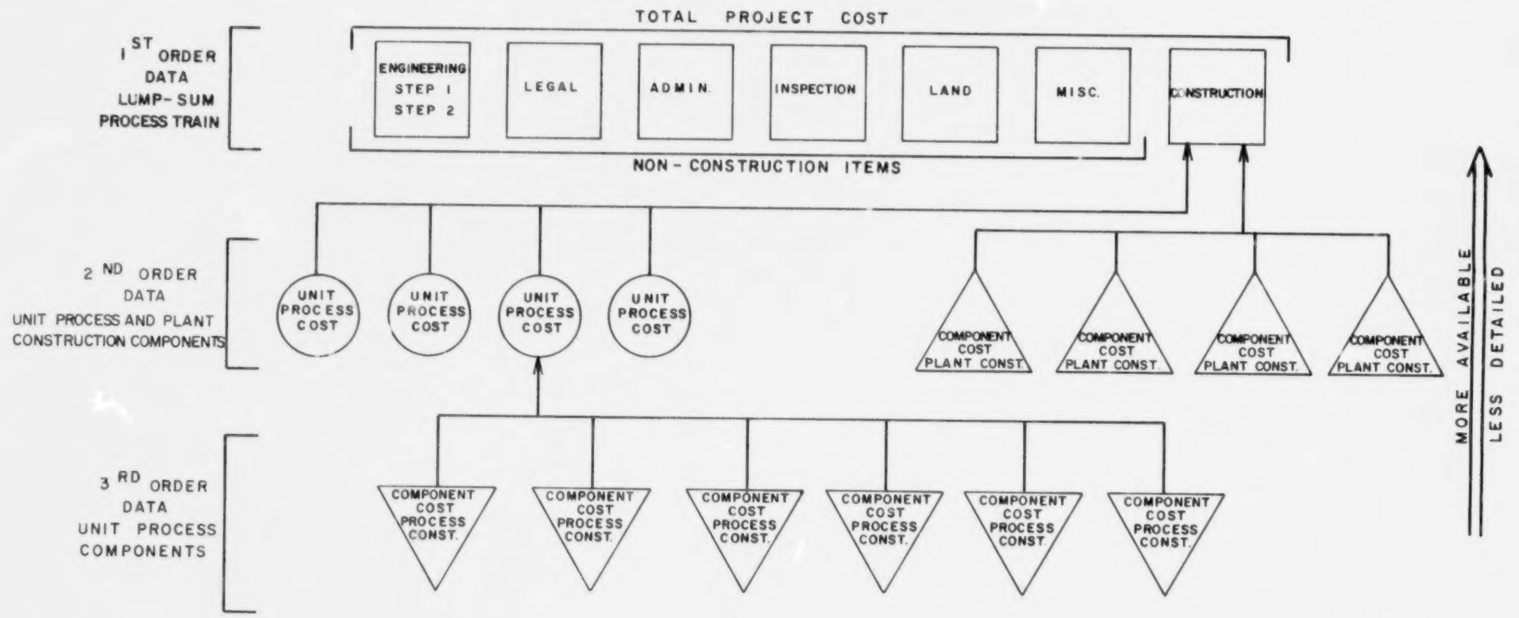
After reviewing the preliminary survey, data collection forms were developed and collection efforts begun in each of the ten EPA regional offices. Data collection forms facilitated classification, keypunching and recall of cost information by the three orders. They also provided for collecting itemized costs for non-construction items such as legal fees, administrative expense, project inspection, Step I, and Step II costs. In addition, physical parameters such as land use, soil conditions and topography were coded. Appendix A provides a detailed description of the data forms with definitions of the coded items.

5.4 Cost Updates

Costs were updated from their bid date to second quarter 1977 dollars using the EPA Municipal Wastewater Treatment Plant Construction Cost Index. Thus, all cost relationships presented in Section 6 are second quarter 1977 dollars. Appendix C describes the procedure employed to bring all reported construction costs to a common dollar base.

FIGURE 5.1

TYPES AND AVAILABILITY OF CONSTRUCTION BID DATA


TOTAL PROJECT COST
1ST ORDER DATA LUMP-SUM PROCESS TRAIN
ENGINEERING STEP 1 STEP 2
LEGAL
ADMIN.
INSPECTION
LAND
MISC.
CONSTRUCTION
NON-CONSTRUCTION ITEMS
2ND ORDER DATA UNIT PROCESS AND PLANT CONSTRUCTION COMPONENTS
UNIT PROCESS COST
UNIT PROCESS COST
UNIT PROCESS COST
UNIT PROCESS COST
COMPONENT COST PLANT CONST.
COMPONENT COST PLANT CONST.
COMPONENT COST PLANT CONST.
COMPONENT COST PLANT CONST.
3RD ORDER DATA UNIT PROCESS COMPONENTS
COMPONENT COST PROCESS CONST.
COMPONENT COST PROCESS CONST.
COMPONENT COST PROCESS CONST.
COMPONENT COST PROCESS CONST.
COMPONENT COST PROCESS CONST.
COMPONENT COST PROCESS CONST.
MORE AVAILABLE
LESS DETAILED

6.0 RESULTS OF DATA ANALYSIS

6.0 RESULTS OF DATA ANALYSIS

6.1 Construction Cost Curves - General

Based on the methodology outlined in Appendix A, analysis of the construction bid data is presented in First, Second and Third order categories. Again, the definitions of these orders are:

First Order	- Total Plant Construction Costs.
Second Order	- Unit Process Construction Cost and Plant Construction Component Cost
Third Order	- Construction Component Costs - Unit Processes

Non-construction costs are not included in the cost relationships developed. Cost curves presented represent construction costs only, as updated to second quarter 1977 dollar values (See Appendix C). Non-construction costs are included in a separate section and must be added to total construction costs to yield complete facility costs.

6.2 Plotting Procedures

A linear regression equation computer plot package was used for initial cost curve development. Each curve was checked for statistical validity by testing the F-value at a 0.05 level of significance. Table 6.1 lists the regression equation, sample size, correlation coefficient and F-test value for each plot presented in Section 6.0. The following is a review of correlation coefficient and F-test value definitions.

TABLE 6.1

CONSTRUCTION COST CURVES - STATISTICAL INFORMATION

FIGURE NO.	EQUATION	SAMPLE SIZE (n)	CORRELATION COEFFICIENT (r)	F-TEST VALUE
6.1	$C = 2.12 \times 10^{6}Q^{.88}$	97	0.92	526.05
6.1a	$C = 2.66 \times 10^{6}Q^{.63}$	19	0.95	166.88
6.1b	$C = 2.73 \times 10^{6}Q^{.83}$	12	0.97	176.85
6.1c	$C = 2.37 \times 10^{6}Q^{.77}$	21	0.93	119.56
6.1d	$C = 1.79 \times 10^{6}Q^{.89}$	7	0.92	29.22
6.1e	$C = 9.21 \times 10^{5}Q^{.90}$	8	0.95	57.84
6.1f	$C = 2.69 \times 10^{6}Q^{.95}$	10	0.96	89.19
6.1g	$C = 1.97 \times 10^{6}Q^{.80}$	12	0.84	24.60
6.2	$C = 2.88 \times 10^{6}Q^{.99}$	40	0.91	172.84
6.2a	$C = 2.88 \times 10^{6}Q^{1.07}$	5	0.98	86.91
6.2b	$C = 3.95 \times 10^{6}Q^{1.05}$	7	0.91	22.89
6.2c	$C = 2.85 \times 10^{6}Q^{.92}$	15	0.90	53.92
6.3	$C = 2.02 \times 10^{6}Q^{.84}$	12	0.90	41.96
6.3a	$C = 2.61 \times 10^{6}Q^{.93}$	5	0.94	24.35
6.4	$C = 2.28 \times 10^{6}Q^{.93}$	32	0.97	544.73
6.4a	$C = 2.44 \times 10^{6}Q^{.89}$	19	0.98	482.93
6.5	$C = 1.35 \times 10^{7}Q^{1.68}$	31	0.69	26.77
6.5a	$C = 1.94 \times 10^{7}Q^{1.87}$	17	0.64	10.36
6.5b	$C = 1.32 \times 10^{7}Q^{1.62}$	14	0.71	12.42
6.5c	$C = 7.00 \times 10^{6}Q^{1.43}$	21	0.85	48.08
	$C = 7.53 \times 10^{5}Q^{.81}$	4	0.98	56.38
6.5d	$C = 2.18 \times 10^{6}Q^{.90}$	9	0.88	24.78
6.6	$C = 9.90 \times 10^{5}Q^{1.30}$	19	0.78	26.55
	$C = 2.53 \times 10^{6}Q^{.84}$	4	0.99	186.45
6.7	$C = 1.74 \times 10^{6}Q^{.83}$	11	0.94	69.62
	$C = 1.11 \times 10^{6}Q^{1.01}$	9	0.79	12.00
6.8	$C = 8.14 \times 10^{5}Q^{.89}$	11	0.87	28.56
6.9	$C = 4.02 \times 10^{6}Q^{.98}$	20	0.89	65.56
	$C = 2.83 \times 10^{6}Q^{.93}$	34	0.84	73.73
6.10	$C = 3.83 \times 10^{6}Q^{1.01}$	11	0.96	95.18
	$C = 3.65 \times 10^{6}Q^{1.21}$	15	0.62	8.28
6.11	$C = 2.29 \times 10^{6}Q^{.95}$	29	0.87	82.70
	$C = 2.25 \times 10^{6}Q^{.89}$	36	0.88	122.66
	$C = 2.08 \times 10^{6}Q^{.84}$	12	0.93	65.16

TABLE 6.1 (cont.)

CONSTRUCTION COST CURVES - STATISTICAL INFORMATION

FIGURE NO.	EQUATION	SAMPLE SIZE(n)	CORRELATION COEFFICIENT (r)	F-TEST VALUE
6.12	$C = 5.79 \times 10^4 Q^{1.17}$	69	0.84	158.52
6.13	$C = 1.47 \times 10^5 Q^{1.03}$	56	0.79	90.32
6.14	$C = 1.09 \times 10^5 Q^{.49}$	8	0.97	93.46
6.15	$C = 6.94 \times 10^4 Q^{1.04}$	28	0.81	49.94
6.16	NO LINE CALCULATED - DATA STATISTICALLY INSIGNIFICANT			
6.17	$C = 2.27 \times 10^5 Q^{.87}$	53	0.90	211.65
6.18	NO LINE CALCULATED - DATA STATISTICALLY INSIGNIFICANT			
6.19	$C = 3.19 \times 10^5 Q^{.92}$	11	0.93	57.59
6.20	$C = 1.09 \times 10^5 Q^{1.01}$	72	0.87	212.78
6.21	$C = 1.85 \times 10^5 Q^{.84}$	41	0.92	226.25
6.22	$C = 2.36 \times 10^4 Q^{1.68}$	25	0.76	30.89
6.23	$C = 9.05 \times 10^5 Q^{1.27}$	36	0.54	13.66
6.24	$C = 3.35 \times 10^5 Q^{1.13}$	18	0.59	8.70
6.25	$C = 5.27 \times 10^4 Q^{.97}$	70	0.80	122.04
6.26	$C = 3.67 \times 10^5 Q^{1.02}$	14	0.86	34.09
6.27	$C = 3.32 \times 10^4 Q^{1.26}$	13	0.66	8.37
6.28	$C = 7.39 \times 10^4 Q^{1.37}$	74	0.79	122.00
6.29	$C = 3.24 \times 10^4 Q^{.91}$	5	0.94	21.65
6.30	$C = 1.65 \times 10^5 Q^{1.02}$	81	0.74	93.35
6.31	$C = 3.28 \times 10^4 Q^{1.10}$	15	0.76	18.03
6.32	$C = 2.99 \times 10^4 Q^{1.14}$	5	0.94	23.59
6.33	$C = 4.26 \times 10^4 Q^{1.36}$	33	0.73	35.01
6.34	$C = 1.47 \times 10^5 Q^{1.14}$	17	0.84	34.68
6.35	$C = 1.12 \times 10^5 Q^{1.12}$	9	0.90	31.59
6.36	NO LINE CALCULATED - DATA STATISTICALLY INSIGNIFICANT			
6.37	NO LINE CALCULATED - DATA STATISTICALLY INSIGNIFICANT			
6.38	$C = 1.51 \times 10^5 Q^{.81}$	5	0.95	25.40
6.39	$C = 3.44 \times 10^4 Q^{1.61}$	24	0.56	10.18
6.40	$C = 9.89 \times 10^4 Q^{1.35}$	30	0.75	35.59
6.41	$C = 8.77 \times 10^4 Q^{1.33}$	13	0.86	30.38
6.42	$C = 4.77 \times 10^4 Q^{1.15}$	40	0.81	70.84
6.43	$C = 1.12 \times 10^5 Q^{.97}$	110	0.77	162.23
6.44	$C = 1.71 \times 10^5 Q^{1.17}$	19	0.80	30.79
6.45	$C = 1.38 \times 10^5 Q^{.97}$	46	0.85	118.86
6.46	$C = 3.68 \times 10^4 Q^{1.12}$	30	0.70	27.02
6.47	$C = 1.36 \times 10^5 Q^{1.00}$	126	0.89	486.32
6.48	$C = 3.10 \times 10^4 Q^{1.24}$	74	0.84	175.53
6.49	$C = 5.06 \times 10^4 Q^{1.12}$	37	0.82	70.13
6.50	$C = 9.96 \times 10^4 Q^{1.03}$	61	0.83	126.10

TABLE 6.1 (cont.)

CONSTRUCTION COST CURVES - STATISTICAL INFORMATION

FIGURE NO.	EQUATION	SAMPLE SIZE(n)	CORRELATION COEFFICIENT (r)	F-TEST VALUE
6.51	$C = 3.14 \times 10^4 Q^{.88}$	63	0.88	211.23
	$C = 1.08 \times 10^4 Q^{1.39}$	15	0.77	18.98
6.52	$C = 3.59 \times 10^4 Q^{1.00}$	13	0.92	58.55
	$C = 2.33 \times 10^4 Q^{.97}$	25	0.77	32.85
6.53	$C = 6.28 \times 10^3 Q^{1.01}$	7	0.86	14.62
	$C = 6.75 \times 10^3 Q^{1.44}$	10	0.89	29.77
	$C = 4.98 \times 10^4 Q^{1.05}$	55	0.81	104.19
	$C = 8.86 \times 10^4 Q^{.95}$	26	0.84	57.52
6.54	$C = 1.77 \times 10^3 Q^{1.10}$	9	0.72	7.61
	$C = 3.46 \times 10^3 Q^{1.46}$	12	0.75	12.76
	$C = 4.94 \times 10^4 Q^{.83}$	68	0.86	179.70
	$C = 4.76 \times 10^4 Q^{.97}$	31	0.90	123.18
	$C = 2.70 \times 10^5 Q^{1.35}$	10	0.73	8.91
6.55	$C = 7.69 \times 10^3 Q^{.77}$	8	0.95	56.98
	$C = 4.15 \times 10^3 Q^{1.20}$	13	0.74	13.68
	$C = 1.45 \times 10^4 Q^{.89}$	66	0.76	88.02
	$C = 1.81 \times 10^4 Q^{1.06}$	21	0.77	28.34
6.56	$C = 1.19 \times 10^6 Q^{1.60}$	19	0.52	6.33
6.57	$C = 4.43 \times 10^4 Q^{1.17}$	16	0.74	16.88
6.58	$C = 8.95 \times 10^4 Q^{.70}$	9	0.87	21.90
6.59	$C = 2.92 \times 10^4 Q^{1.23}$	15	0.75	17.06
6.60	$C = 5.50 \times 10^3 Q^{1.45}$	26	0.58	12.11
6.61	$C = 3.71 \times 10^4 Q^{1.27}$	38	0.64	25.36
6.62	$C = 1.47 \times 10^4 Q^{.71}$	4	0.95	20.23
	$C = 1.63 \times 10^4 Q^{1.19}$	33	0.62	19.87

6.2.1 Correlation Coefficient (r)

The correlation coefficient (r) is a measure of the degree of closeness of the linear relationship between two variables. It varies from zero (no relationship between the two variables) to ± 1 (perfect linear relationship). The sign of r is the same as that of a in the regression equation, $Y = a + bX$. Thus, if $r = -1$, all points are on the regression line sloping down to the right. The independent variable (X) accounts for the variability in the dependent variable (Y). For example, if $r = 0.73$, then 73 percent of the variance in Y is explained by X; the balance of 27 percent is simply not explained by the independent variable X and is left unaccounted for in the relationship of the two designated variables.

6.2.2 F-Test Value

The F-test value is used to test the goodness of the fit of a regression curve. The F-value can be compared with tabled values to give a test of the hypothesis that the correlation coefficient is zero against the alternative that the equation as a whole defines a significant relationship between the two variables. The F-value is the ratio of the mean square due to regression to the deviation's mean square:

$$\text{F-value} = \frac{\text{SSFE}/K}{\text{RSS}/(N - K - 1)}$$

The ratio is compared to the corresponding value from an F-table with K and (N - K - 1) degrees of freedom, where N is the total number of points, K is the degrees of freedom due to regression, and N - K - 1 is the degrees of freedom due to deviations. (SSFE implies sum of square due to fitted equation; RSS means residual sum of squares.) In general, the higher a given F-value the greater the probability that the relationship is significant.

For categories of cost information with insufficient data for valid cost relationships no plots were included. A tabulation of available data is included at the end of the pertinent group of curves for reference purposes. The two main reasons for lack of construction cost information for various categories were: (1) a lack of EPA grants which had progressed to the bidding stage for a specific category of costs and (2) unusable bid formats which made actual construction costs unobtainable.

6.3 First Order Cost Curves

6.3.1 New Construction

Figures 6.1 through 6.5 show graphs of total construction cost versus design flow for mechanical wastewater treatment plants. Since very few municipal physical-chemical treatment plants have been built under PL 92-500, no cost information was collected for physical-chemical treatment facilities. Lagoons, both aerated and stabilization ponds, have been analyzed separately in Figures 6.5 through 6.5d.

Figure 6.1 shows the resultant plot of total construction cost against design flow for construction of new secondary treatment plants. It includes 96 projects nationwide ranging in size from 0.02 mgd to 56.0 mgd. The process train of each facility is not a parameter of this curve.

Regional curves for new, secondary plants were developed using the data of Figure 6.1 and are presented as Figures 6.1a thru 6.1g.

For Regions IV, VII and VIII, insufficient data were collected from which to construct cost curves, so Table 6.6 lists the cost data for those regions.

Figure 6.2 relates total construction cost to design flow for new construction of treatment plants providing levels of treatment greater than secondary. Greater than secondary treatment is defined in this study as BOD (Biochemical Oxygen Demand) and SS (Suspended Solids) effluent concentration requirements of less than 30 mg/l each or removals greater than 85 percent, whichever is more stringent. Plants classified as greater than secondary only had no nutrient removal processes included in the facility design. Figures 6.2a through 6.2c are plots of cost curves for EPA Regions II, III, and V, and Table 6.7 lists available data for the remaining regions.

The cost curve for total contruction cost versus design flow for secondary facilities with nutrient removal requirements is shown on Figure 6.3. Typical plants in this category are required to produce 30 mg/l BOD and SS each and 0.2 mg/l phosphorus as effluent concentrations. Other nutrients commonly restricted by NPDES (National Pollutant Discharge Elimination System) permits were ammonia and nitrate compounds. The bulk of cost data for secondary treatment with nutrient removal originated from facilities in the Great Lakes region where nutrient pollution problems are severe. Figure 6.3a is the cost curve for Region V. Table 6.8 lists data for regions where plots were not statistically significant.

Figure 6.4 presents total construction cost versus design flow for plants required to produce greater than secondary treatment with nutrient removal. Again, this curve is heavily weighted with Region V facilities tributary to the Great Lakes. Figure 6.4a shows cost versus design flow for Region V; Table 6.9 tabulates remaining regional cost data.

Costs for stabilization ponds are shown in Figure 6.5. Facilities incorporated in this curve include discharging and non-discharging lagoons, lined and unlined ponds and facilities with and without pumping. Figures 6.5a and 6.5b represent stabilization pond data from discharging and non-discharging ponds, respectively.

Since stabilization pond design is sensitive to local climatic conditions, cost relationships were developed for warm and cold climate lagoon construction and plotted in Figure 6.5c. Cold climate facilities were defined as those north of 38° N. latitude while warm climate facilities were those south of that parallel. This division was based on the assumption that the surfaces of ponds north of the 38th parallel would probably freeze in winter while those south of 38° would not. Admittedly, there is a degree of subjectivity inherent in this assumption. Variation from the 38th parallel as the southern limit of pond freezing will occur due to variation in climatic and geographic conditions, particularly elevation differences and warm ocean currents.

Figure 6.5d relates construction costs for aerated lagoons to design flow. There were insufficient data to produce separate aerated lagoon cost curves for any of the EPA Regions.

6.3.2 Treatment Plant Enlargement

Construction cost information was collected for existing treatment facilities which were being enlarged to accept increased design flows. Facilities which were improving their level of treatment simultaneously with expansion were not included in this category. Since actual flows immediately after plant enlargement are often a fraction of the design flow, improved treatment may be a result of plant enlargement in many cases. However, if design parameters were based on the need to enlarge the facility only, the plant was classified as an enlargement.

Figure 6.6 presents cost curves for enlarging secondary and advanced wastewater treatment plants. Note that total construction cost is plotted versus the increase in plant design flow. This curve is based on mechanical plant data only and does not include lagoons. Also, insufficient data were available to separate the AWT curve into the categories of greater than secondary, secondary with nutrient removal and greater than secondary with nutrient removal.

6.3.3 Upgrading of Treatment Plants

Existing facilities for which design flow remained constant while the level of treatment was improved by means of expansion of existing unit processes and/or addition of new unit processes were categorized as upgraded facilities.

Figures 6.7 and 6.8 present cost relationships for upgrading existing primary and secondary plants, respectively. Insufficient data were accumulated to define separately upgrading to each category of advanced wastewater treatment (i.e., greater than secondary, secondary with nutrient removal or greater than secondary with nutrient removal). These curves are based on mechanical plant data only and do not include upgraded lagoon facilities.

6.3.4 Treatment Plant Enlarging & Upgrading

Construction costs for existing facilities enlarged and upgraded simultaneously are presented in Figures 6.9 through 6.11. Figure 6.9

includes curves for enlarging and upgrading primary treatment plants to either secondary or advanced wastewater treatment.

Several facilities were sampled for this study which achieved, before upgrading, a level of treatment defined as advanced primary. Many of these facilities were trickling filter plants producing an effluent consistency between 30 and 50 mg/l each for BOD and SS. Due to the July 1, 1977, deadline specified by PL 92-500 for the achievement of secondary treatment levels, these plants were upgraded to either secondary or AWT capability. There were too few of these advanced primary plants which were not simultaneously enlarged to produce cost curves in the "upgrade only" section. Figure 6.10 presents cost curves for enlarging and upgrading from advanced primary treatment to secondary or AWT.

Figure 6.11 defines cost relationships for enlarging and upgrading secondary facilities to each of the three AWT categories.

6.4 Second Order Cost Curves

6.4.1 Unit Process Costs

Cost relationships for individual unit processes in-place are presented in Figures 6.12 through 6.41. These curves utilize costs for newly constructed processes only and do not include data for enlarging and/or upgrading of individual processes. Note, however, that when enlarging and/or upgrading an entire treatment plant, new unit processes are often constructed. Cost data for such processes, when available, were included in this section of curves. Costs for enlarging and/or upgrading individual unit processes were rarely provided in construction bid tabulations or contractor partial payment requests. In addition, design considerations for enlarging and/or upgrading of a particular unit process are particularly job specific, limiting the applicability of average cost curves. For these reasons cost curves for enlarging and/or upgrading were not developed on the unit process level. Table 6.10 directly precedes Figure 6.12 in the text and lists all the unit processes which were included in the study and for which cost data were sought. Several of these processes had insufficient data with which to plot cost curves. For those unit processes with valid cost relationships, log-log linear regression equations are listed also.

Of particular concern during data collection and analysis was the definition of each unit process with respect to construction components. During the initial survey of EPA construction grant files it became evident that construction components included in a lump sum cost for a given unit process varied considerably from project to project. For example, one bid tabulation might allocate the associated costs for controls and instrumentation to each of several unit processes while another bid may have included them in a lump sum cost for the entire plant. To overcome this problem, each unit process was defined to include certain construction components and cost data were collected for those processes including those components and only those components. Unit process costs including more or less than the specified construction component costs as shown in Table 6.2 were not utilized in second

Table 6.2

CONSTRUCTION COMPONENT CLASSIFICATION

A. The following construction components were included in the cost data for all unit processes except those listed in Part B below:

- Process Piping
- Equipment
- Concrete
- Steel

B. The following unit processes included excavation costs in addition to the construction components listed in Part A above:

- Oxidation Ponds
- Aerated Lagoons
- Flow Equalization
- Air Drying of Sludge
- Sludge Lagoons

C. Construction components commonly bid on a lump sum basis for an entire plant were:

- Mobilization
- Sitework
- Excavation
- Pilings, Special Foundations & Dewatering
- Electrical
- Controls and Instrumentation
- Yard Piping
- Heating, Ventilating & Air Conditioning
- Miscellaneous

order curves. Construction components listed in this table are assumed to be in place including both materials and associated labor.

6.4.2 Lump Sum Construction Component Costs

Since bids for unit processes commonly employed in standard process trains usually include process piping, equipment, concrete and steel, other component items are often bid in lump sum form for the entire plant. For these components, tabulated in Table 6.2, Part C, cost curves were developed and presented as Figures 6.42 through 6.50.

Methods and considerations for employing unit process and lump sum construction component costs in developing total plant costs are discussed in Section 6.8.

6.5 Third Order Cost Curves

During the process of accumulating total construction costs for given unit processes, separate costs for each of the construction components of a specific process were often available in bid tabulations. For instance, the costs for concrete and equipment for a primary sedimentation basin may have been itemized separately in addition to the total cost for the entire unit process. In practice, within the bid tabulations or partial payment requests, the breakdown of unit process prices into construction components was irregular. Furthermore, variation in design standards and practices as well as job specific requirements cause significant variations in the relative cost of construction components.

Understanding these factors, construction component costs for each unit process were collected when available and Figures 6.51 through 6.62 were developed from these data. Each figure represents a specific unit process and presents cost curves for each construction component of that process for which sufficient data were available to create a statistically valid relationship.

If sufficient data were available, each unit process figure would contain a construction component curve for process component shown in Table 6.6. It is anticipated that missing component curves will be drawn as more treatment plants are constructed and bid data are collected.

6.6 Unit Costs

During the preliminary survey to determine which cost data to collect from EPA Grant files it was noticed that in some cases unit costs and quantities for various construction components were tabulated in contractors' bids. For example, concrete bid items may have specified the number of cubic yards and the price per cubic yard. Allowance was made for the collection of this information on the data forms. It was hoped that this unit cost information would be of sufficient quantity and consistency to be employed as input to other cost estimating models such as CAPDET. In the course of reviewing bids for facilities nationwide, it became evident that this was not the case. Unit costs and quantities were rarely itemized for most construction components. For concrete work and excavation unit costs were more frequent but were so job specific and design dependent that classification was difficult. For these reasons third-order cost curves for unit prices and quantities were not developed.

6.7 Non-Construction Costs

A significant percentage of the total expense of a wastewater treatment project results from non-construction cost items. This cost category includes Step I and Step II EPA Grant expenses and the non-construction costs associated with Step III funding such as administration, architect/engineer fees, construction inspection expenses and contingency allowances. These non-construction costs were readily available during the course of data collection from the EPA Grant files.

Table 6.3 summarizes the average ratios of Step III non-construction costs to total construction costs for facilities sampled in this study. Note that national average ratios for a particular non-construction cost item may be lower than the regional figures since some projects had no expenditures for certain items.

In addition to Step III non-construction costs the percentage of construction costs for Step I and Step II grants have also been analyzed. Based only on projects which have proceeded though individual Step I, II and III phases, the percentages indicated at the bottom of Table 6.3 were

TABLE 6.3

AVERAGE NON-CONSTRUCTION COSTS FOR WASTEWATER TREATMENT PLANTS

NEW CONSTRUCTION
NON-CONSTRUCTION COSTS (NCC)/TOTAL CONSTRUCTION COSTS (TCC)

STEP III NON-CONS. ITEMS	REG 1	REG 2	REG 3	REG 4	REG 5	REG 6	REG 7	REG 8	REG 9	REG 10	NATIONAL	# PTS.
Admin/Legal	.0212	.0125	.0163	.0047	.0061	.0106	.0049	.0030	.0091	.0118	.0086	183
Preliminary		.0016					.0001	.0009	.0005	.0005	.0002	8
Land, Struct., Row	.0512		.0020		.0007	.0017	.0021	.0002	.0040	.0007	.0018	14
A/E Basic Fees		.0318	.0891	.0164	.0397	.0139	.0069	.0171	.0434	.0486	.0290	29
Other A/E Fees	.0134	.0168		.0124	.0173	.0057	.0051	.0262	.0274	.0034	.0124	27
Inspection	.0357	.0185	.0125	.0149	.0008	.0083	.0273	.0192	.0020	.0200	.0079	54
Land Development												0
Relocation								.0003	.0005		.0001	4
Relocation Pmts.												0
Demolition & Removal										.0030	.0001	1
Bond Interest		.0011	.0014								.0002	2
Contintency	.0542	.0571	.0571	.0933	.0271	.0445	.0335	.0420	.0482	.0369	.0407	211
Indirect Costs		.0009			.0020						.0009	6
Miscellaneous		.0003			.0006	.0025	.0071	.0014		.0004	.0007	12
Sig. Inelig. Costs	.0012		.0029								.0003	3
Equipment			.0002	.0087	.0015	.0002		.0033	.0004	.0050	.0015	27
Other Eligible	.0121		.0024	.0135	.0003		.0011	.0004	.0063		.0020	18
	0.1890	0.1406	0.1839	0.1639	0.0961	0.0874	0.0881	0.1140	0.1418	0.1303	0.1064	TOTAL
											0.0350	STEP 1/TCC
											0.0850	STEP 2/TCC
											0.2264	TOTAL NON-CONS. COST/TCC

calculated. Step I and II percentages were then added to the Step III non-construction cost percentages to yield total project non-construction cost percentages for new wastewater treatment facilities.

Curves for first, second, and third order cost relationships developed in the preceding sections include construction costs only. Non-construction costs must be added to produce complete project costs for EPA funded treatment plants. See Section 6.8 for examples which utilize non-construction cost information.

6.8 Use of the Cost Curves

There are two methods of arriving at complete wastewater treatment plant cost estimates using the cost relationships presented in the preceding section. The first utilizes first order or total plant construction costs - the second utilizes second order or unit process construction costs. Both must be combined with non-construction costs to provide total costs for complete projects.

Second order cost curves have been developed for new construction only; thus enlarge and/or upgrade costs cannot be derived based on unit process costs. All cost curves have correlated construction costs to design flow in millions of gallons per day.

Table 6.4 presents comparisons of construction costs for three secondary, activated sludge treatment plants. In this comparison,

TABLE 6.4

CONSTRUCTION COST COMPARISONS - 1st vs 2nd ORDER DATA
(Costs in 2nd Quarter 1977 Dollars)

SECONDARY - ACTIVATED SLUDGE PLANTS

PROCESS DESCRIPTION	1.0 MGD	10.0 MGD	20.0 MGD
Preliminary Treatment	$ 58,000	$ 856,000	$ 1,927,000
Influent Pumping	147,000	771,000	3,216,000
Primary Sedimentation	69,000	761,000	1,565,000
Activated Sludge (1)	227,000	1,683,000	3,076,000
Secondary Clarification	109,000	1,115,000	2,246,000
Effluent Chlorination	53,000	492,000	963,000
Effluent Outfall	74,000	1,732,000	4,478,000
Gravity Thickening	33,000	413,000	885,000
Aerobic Digestion	147,000	2,029,000	4,472,000
Other Sludge Handling	43,000	976,000	2,205,000
Mechanical Dewatering	34,000	1,401,000	4,278,000
Landfill of Sludge	(No Capital Cost)	(No Capital Cost)	(No Capital Cost)
Control/Lab. Main. Bldg.	165,000	1,728,000	3,504,000
Cost of Unit Processes	1,159,000	13,957,000	32,815,000
Mobilization	48,000	674,000	1,495,000
Sitework	112,000	1,045,000	2,047,000
Excavation	138,000	1,421,000	2,523,000
Electrical	136,000	1,360,000	2,720,000
Controls & Instrumentation	51,000	667,000	1,450,000
Yard Piping	100,000	1,067,000	2,179,000
HVAC	31,000	539,000	1,272,000
Total Cons. Component Cost	616,000	6,773,000	13,686,000
Total Plant 2nd Order	$1,775,000	$20,730,000	$46,501,000
Total Plant 1st order	$2,120,000	$16,082,000	$29,597,000

(1) Included in [illegible] Cost are equipment, concrete, steel and inter-processing pumping

second-order cost estimates have been made by combining costs for the specific unit processes listed with construction component costs for the entire plant. Unit process costs are from Figures 6.12 through 6.41 while construction component costs are derived from Figures 6.42 through 6.50. The first order or total plant cost was derived from Figure 6.1 for new, secondary treatment plants. This table presents construction costs only; non-construction costs are added as shown in Table 6.9.

It can be seen from this comparison that, for the particular process train selected, the first and second order cost estimates are equal for some design flow between one and ten mgd, roughly 2 mgd. Divergence in cost based on the two estimating schemes occurs above and below this design flow. Obviously, the ratio of first and second order cost estimates will change as the unit processes employed in the second order design change. Since first order cost curves are averages of many process train variations they remain constant for a given design flow. The unit process train employed in Table 6.4 was assumed to be typical of a secondary treatment layout for municipal wastewater treatment. Variations will obviously occur based on specific requirements of each particular project considered.

Table 6.5 lists the total project costs for activated sludge plants as shown in Table 6.4, but with non-construction costs added.

Construction costs based on third order cost curves presented in Figures 6.51 through 6.62 could not be developed due to insufficient

TABLE 6.5

TOTAL PROJECT COSTS

(SECOND QUARTER 1977 DOLLARS)

	1.0 mgd		10.0 mgd		20.0 mgd	
	1st order	2nd order	1st order	2nd order	1st order	2nd order
Construction Cost (1)	2,120,000	1,775,000	16,082,000	20,730,000	29,597,000	46,501,000
Step I Cost	74,000	62,000	563,000	726,000	1,036,000	1,628,000
Step II Cost	180,000	151,000	1,367,000	1,762,000	2,516,000	3,953,000
Step III Non-Cons (2)	226,000	189,000	1,711,000	2,206,000	3,149,000	4,948,000
Total Project Cost	2,600,000	2,177,000	19,723,000	25,424,000	36,288,000	57,030,000

1. From Table 6.4.
2. Non-construction percentages are derived from Table 6.3 based on average cost distributions for municipal wastewater treatment. Variations will occur based on the specific requirements of each particular plant considered.

data presently available. Eventually, unit process costs may be calculated by combining the costs of the various construction components comprising the specific process. The accumulation and analysis of additional construction bid data in the future will allow more detailed and accurate definition of construction component costs and therefore unit process and plant costs.

FIRST ORDER CONSTRUCTION COST CURVES

(PLANT CONSTRUCTION COSTS)

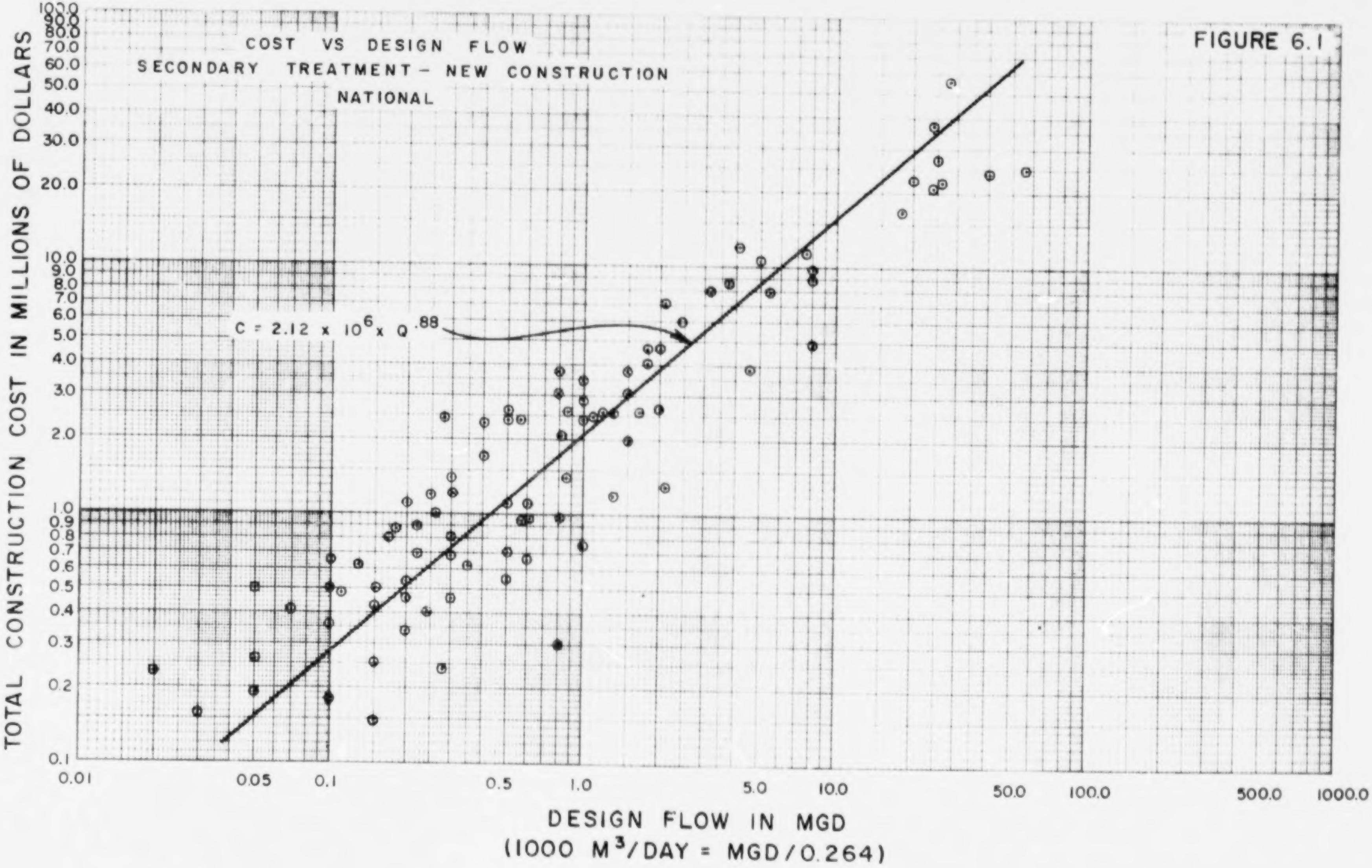
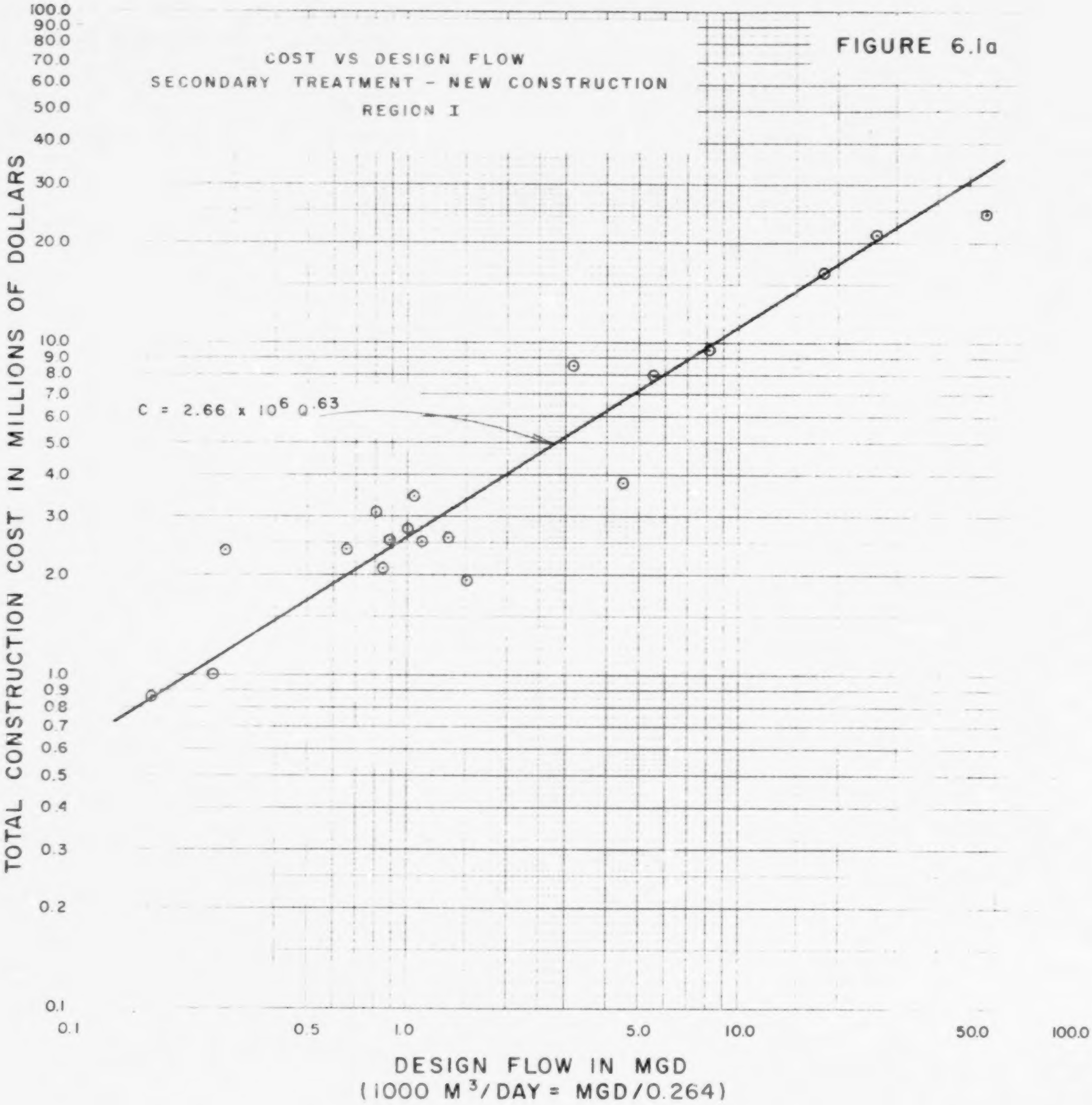


FIGURE 6.1

COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
NATIONAL
C = 2.12 x 10^6 x Q^.88
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
0.01
0.05
0.1
0.5
1.0
5.0
10.0
50.0
100.0
500.0
1000.0
DESIGN FLOW IN MGD
(1000 M3/DAY = MGD/0.264)

FIGURE 6.1a


COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
REGION I
$C = 2.66 \times 10^6 Q^{.63}$
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

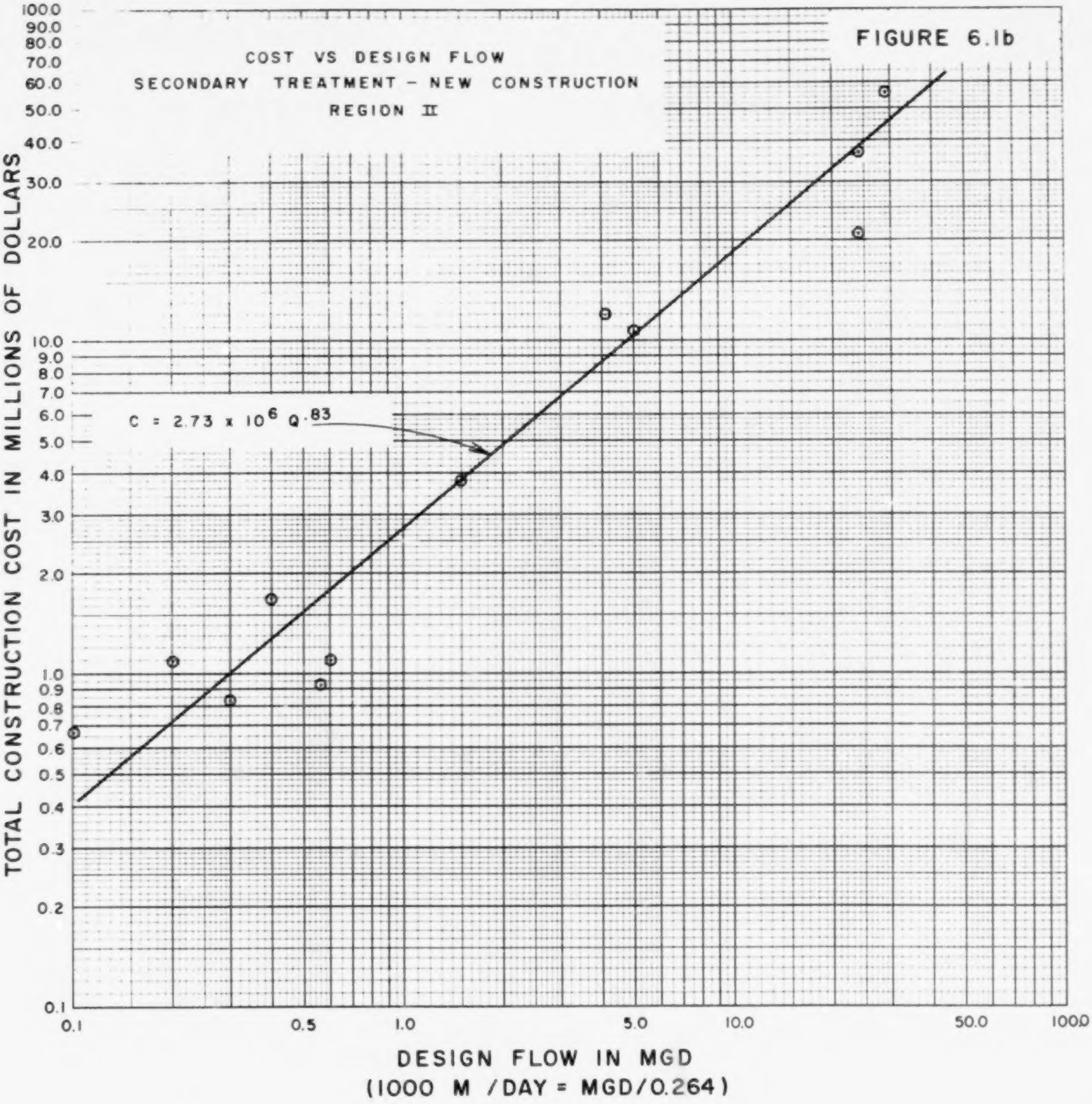


FIGURE 6.1b

COST VS DESIGN FLOW
SECONDARY TREATMENT – NEW CONSTRUCTION
REGION II

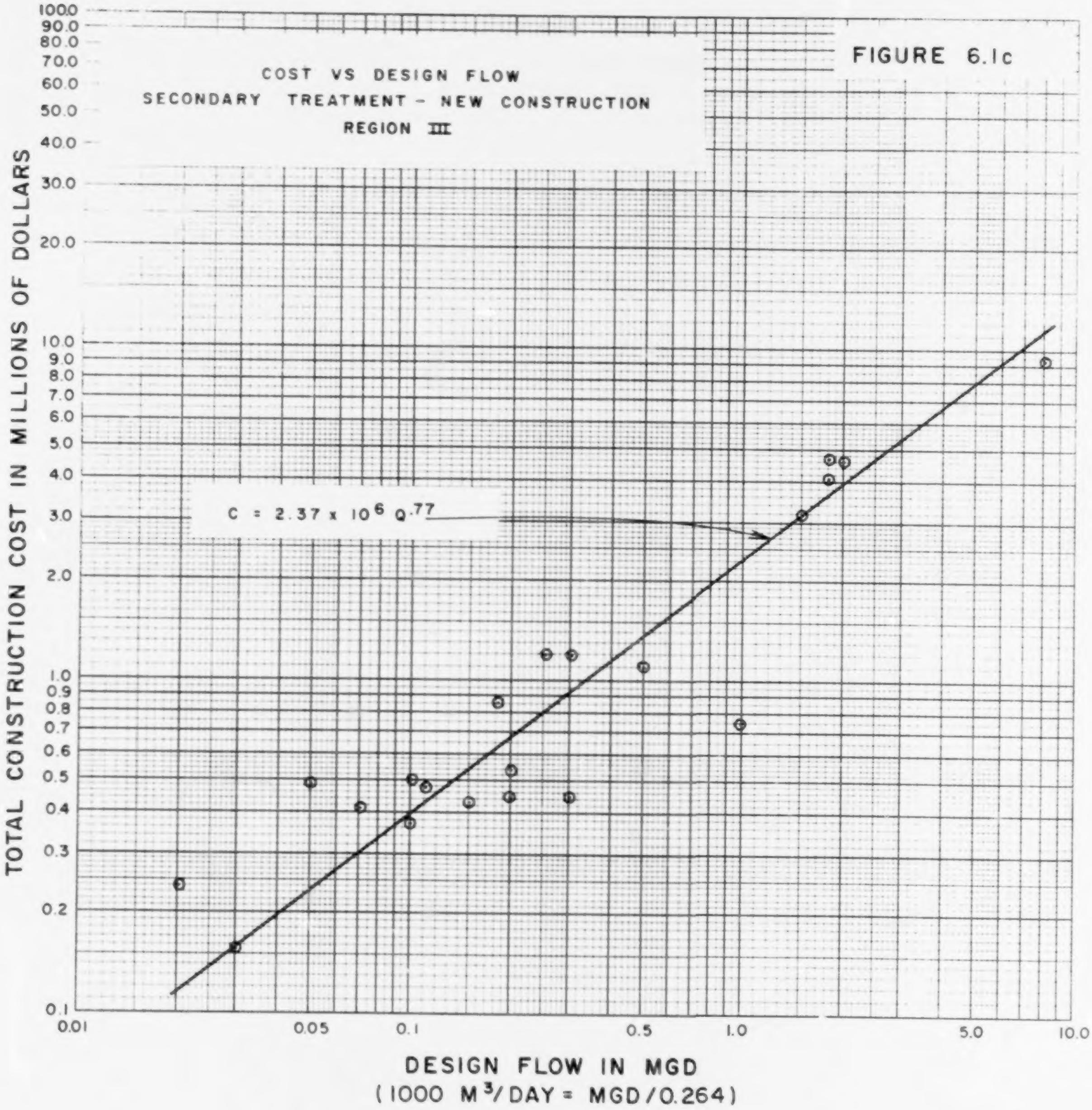


FIGURE 6.1c
COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
REGION III
C = 2.37 x 10^6 Q^.77
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01
0.05
0.1
0.5
1.0
5.0
10.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

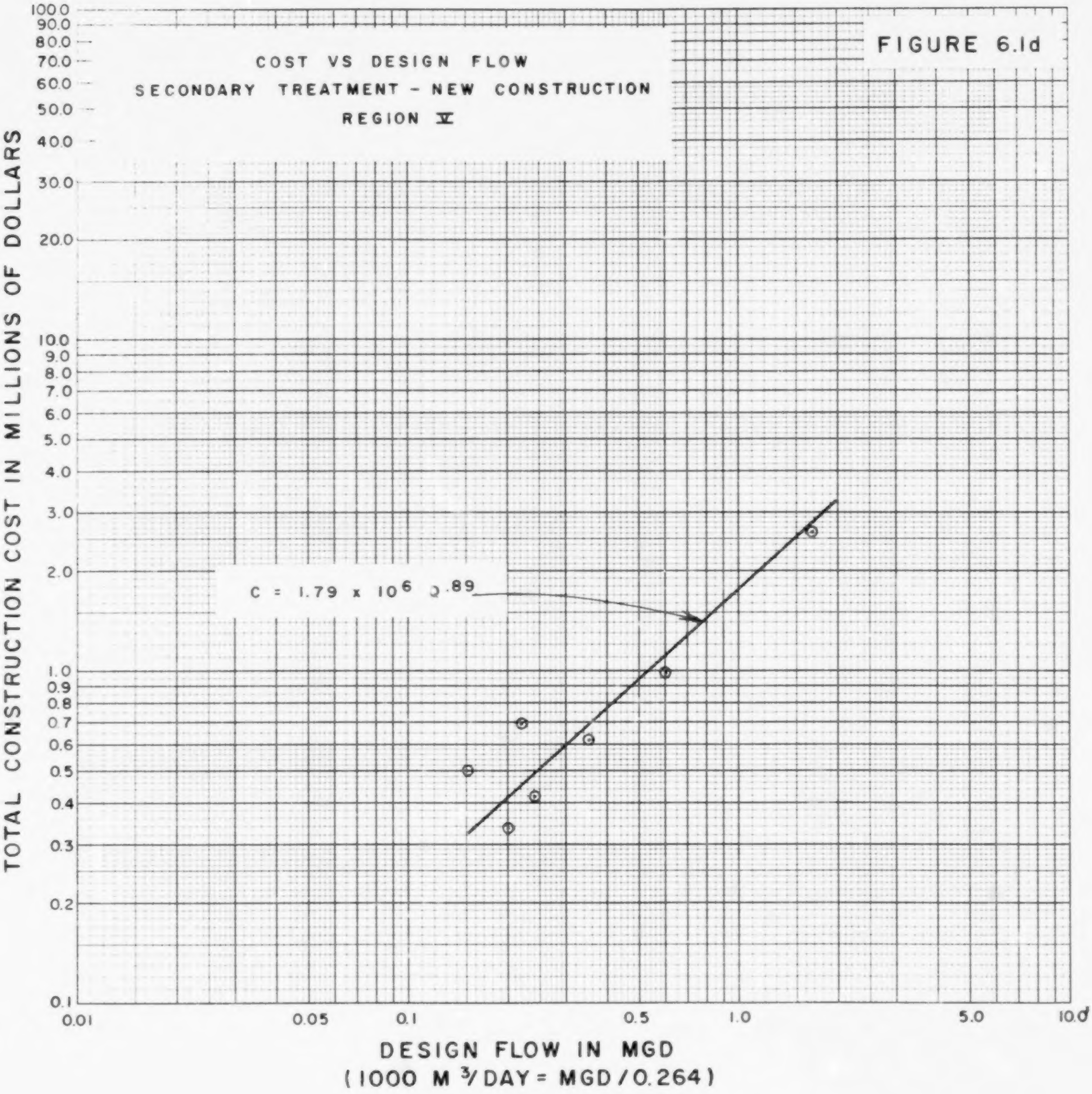
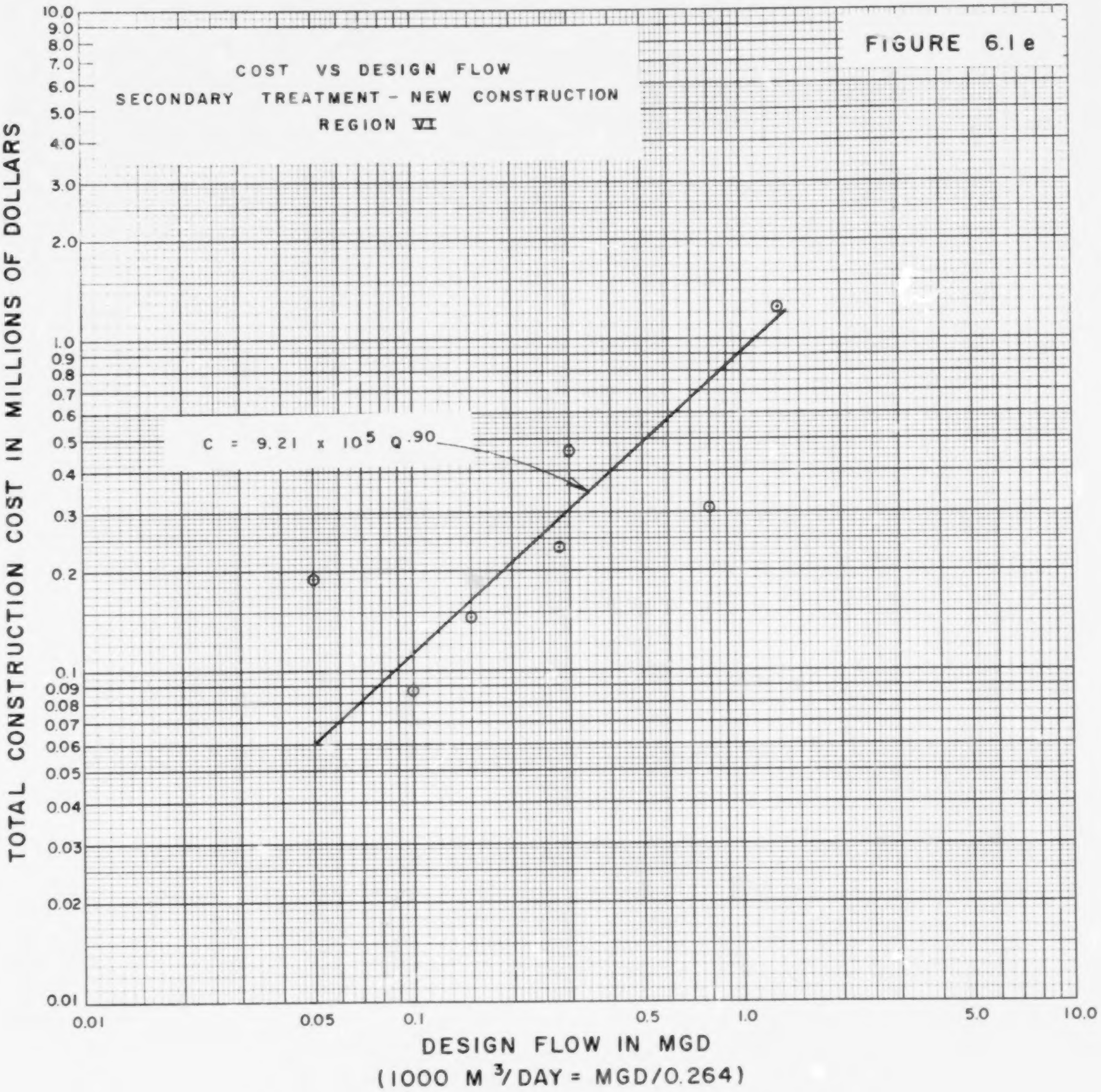
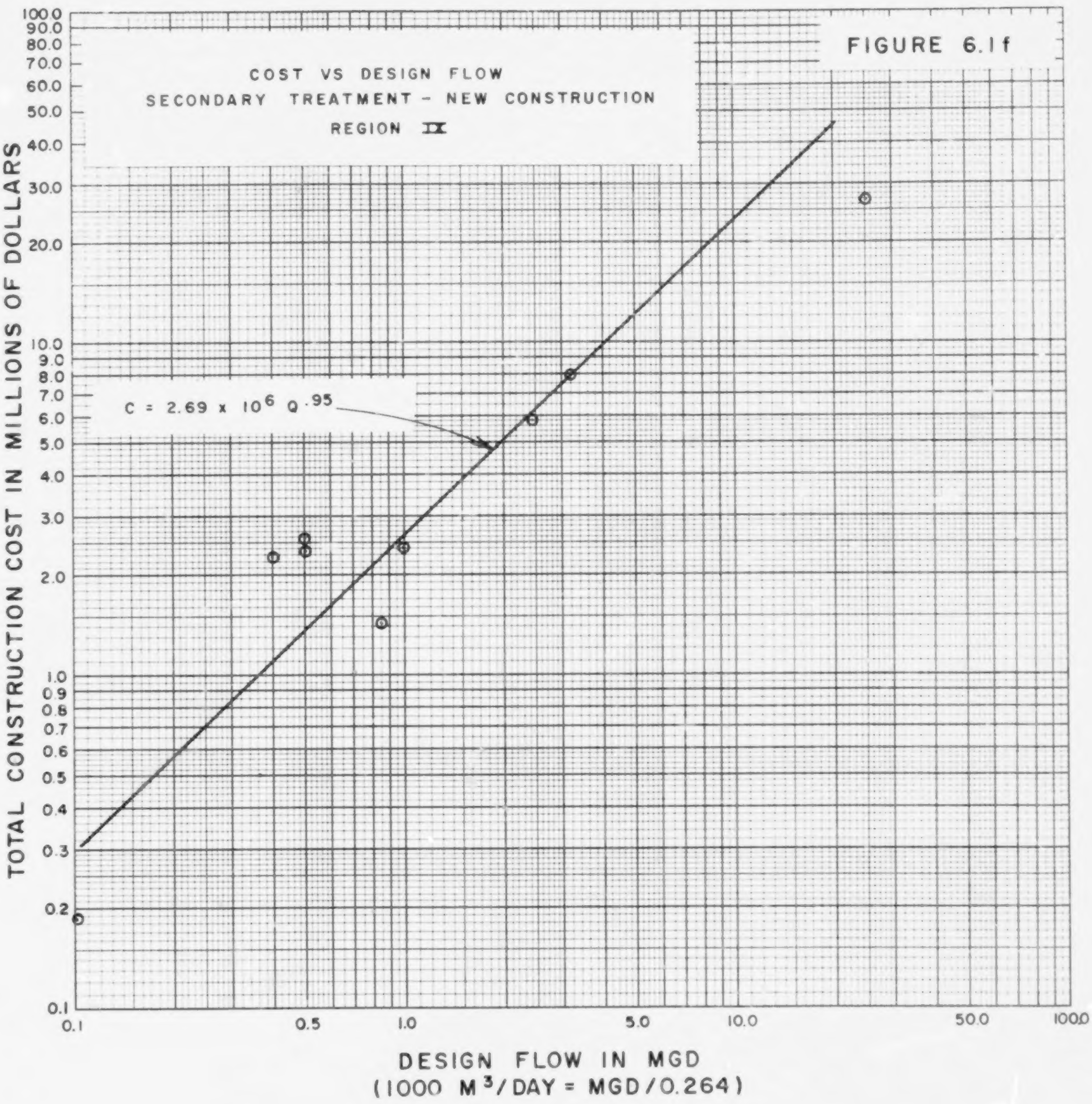


FIGURE 6.1d

COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
REGION V

FIGURE 6.1e


COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
REGION VI
C = 9.21 x 10^5 Q^.90
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.01
0.05
0.1
0.5
1.0
5.0
10.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

FIGURE 6.1f
COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
REGION IX
C = 2.69 x 10^6 Q^.95
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

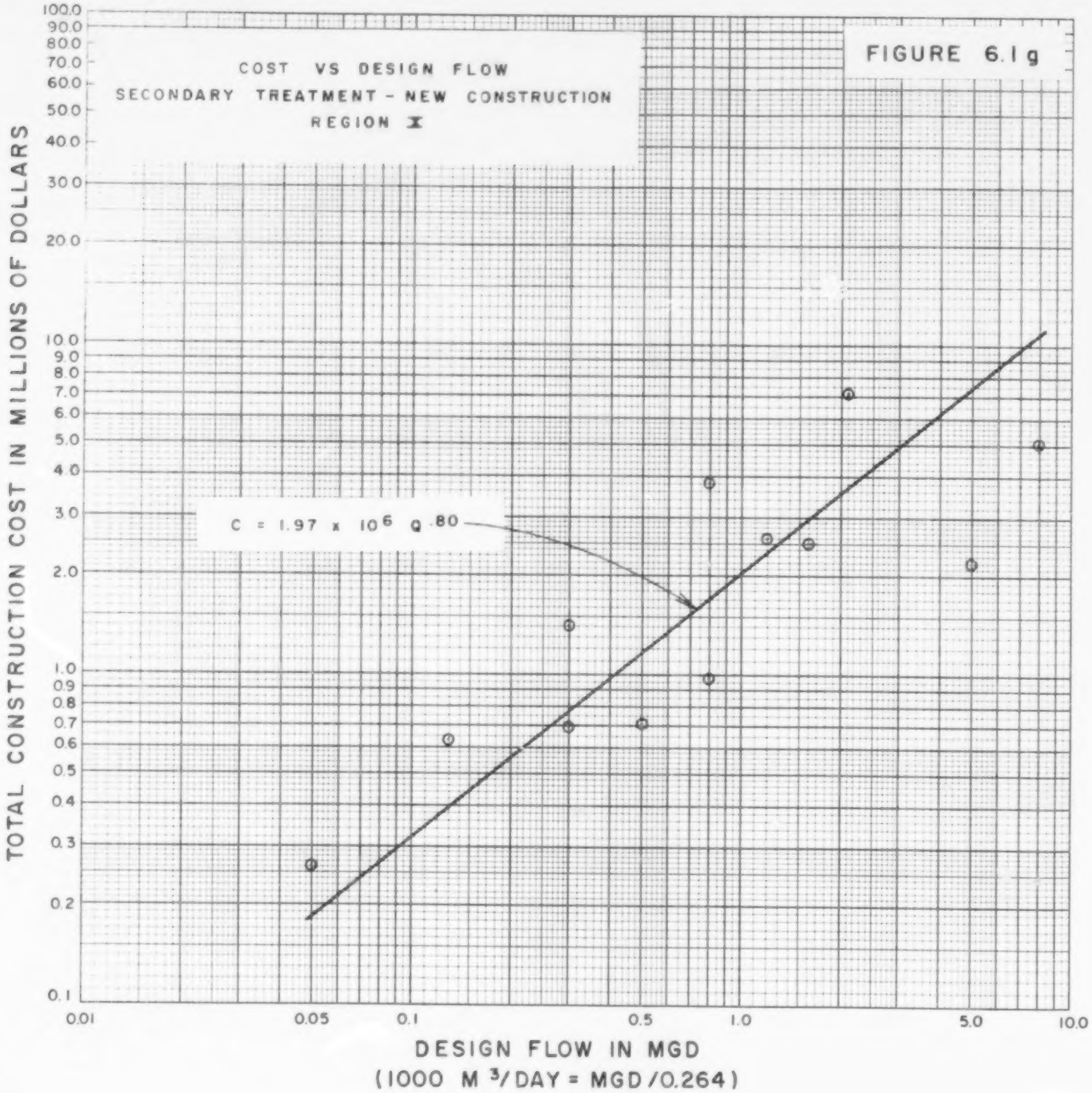

COST VS DESIGN FLOW
SECONDARY TREATMENT - NEW CONSTRUCTION
REGION X
FIGURE 6.1g
C = 1.97 x 10^6 Q^.80
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01
0.05
0.1
0.5
1.0
5.0
10.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

TABLE 6.6

Secondary Treatment - New Construction

Regional Data - Unplotted

Region	Grant No.	Design Flow (mgd)	Cost ($)
IV	010296	.15	251,847
	130315	.50	555,638
VII	290603	2.11	1,316,238
	290629	7.50	11,203,086
	310407	2.00	2,678,754
	310421	.22	893,239
VIII	080329	20.00	22,739,187
	300204	.60	666,286

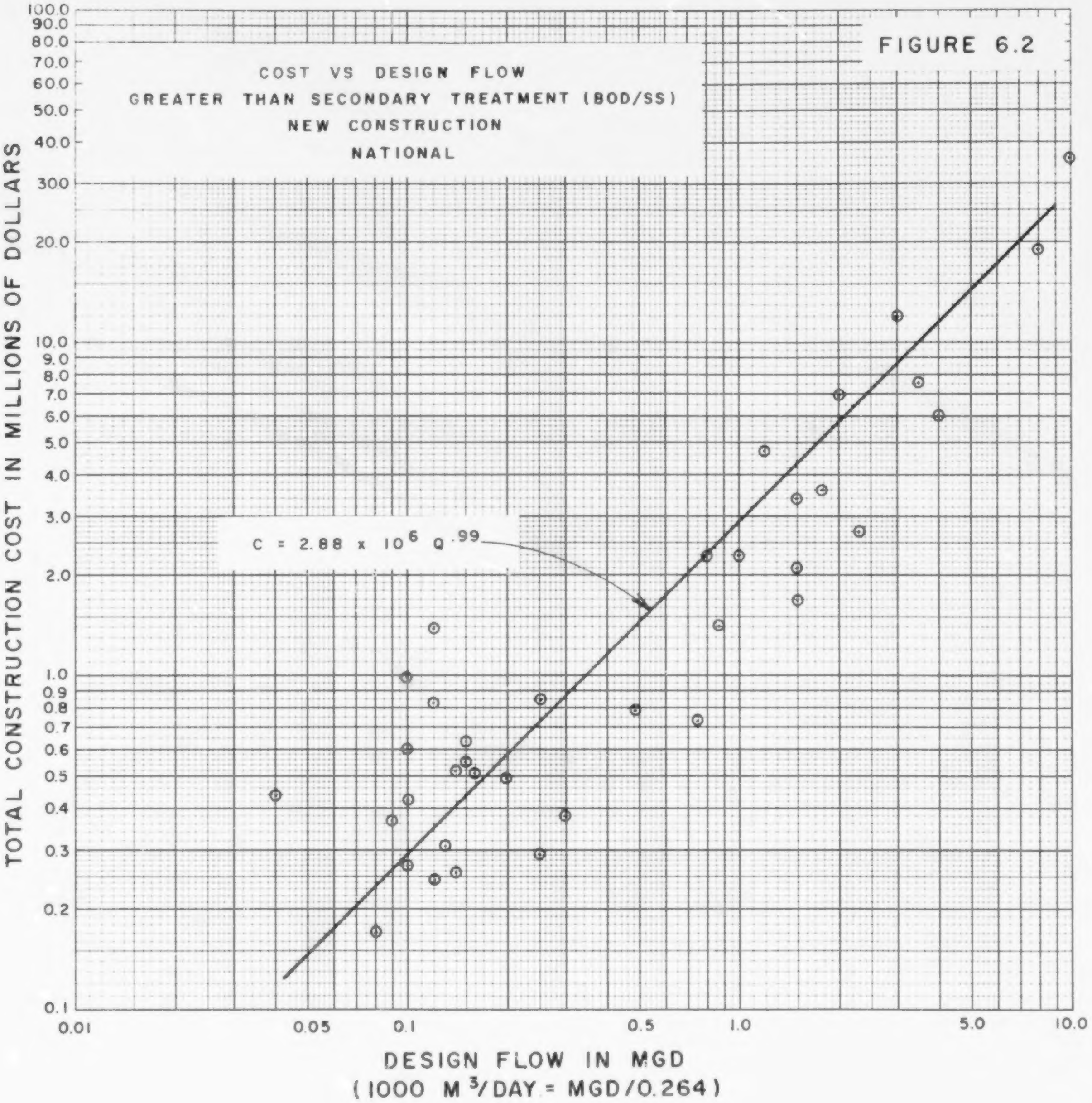
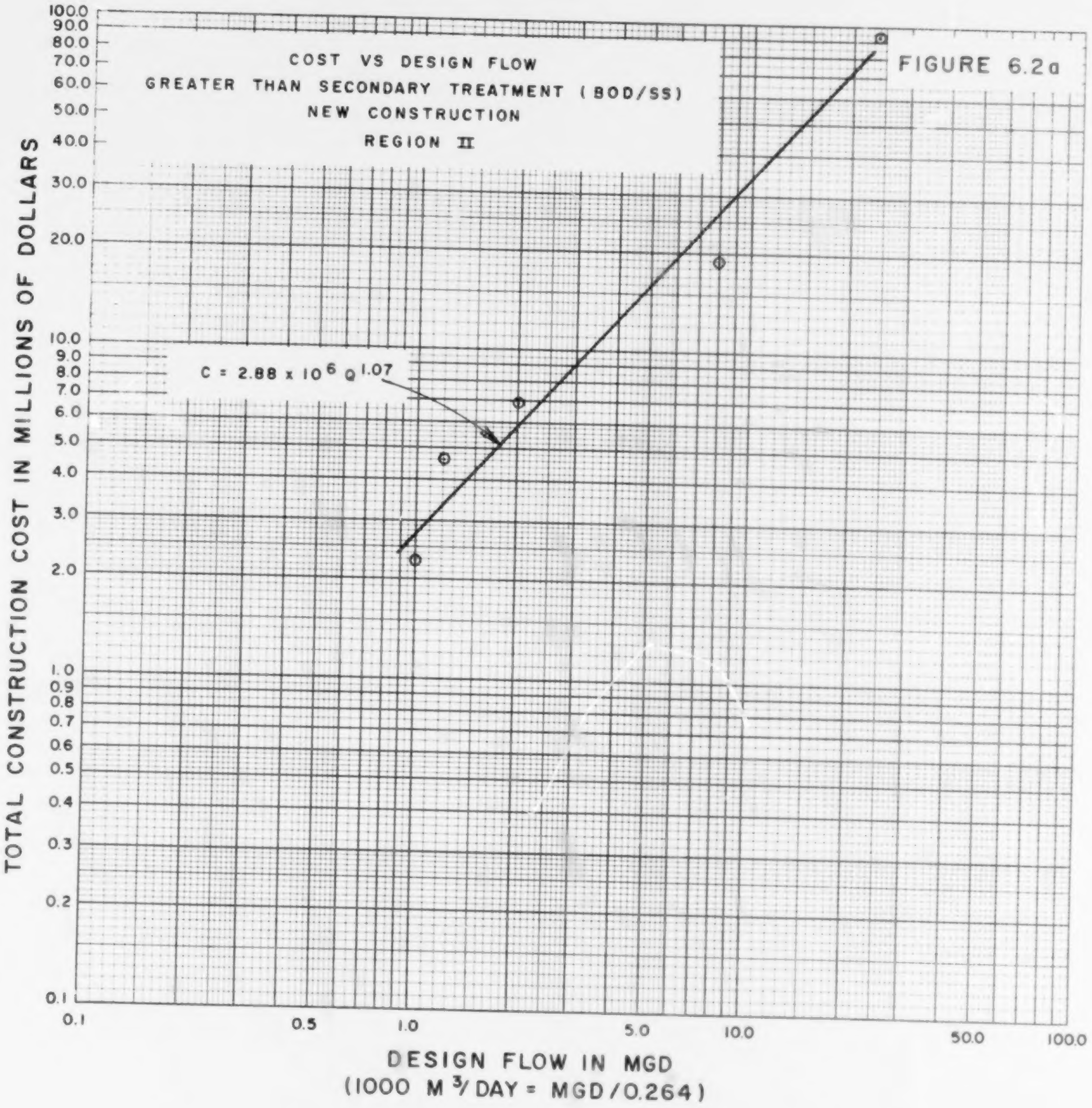


FIGURE 6.2

COST VS DESIGN FLOW
GREATER THAN SECONDARY TREATMENT (BOD/SS)
NEW CONSTRUCTION
NATIONAL


COST VS DESIGN FLOW
GREATER THAN SECONDARY TREATMENT (BOD/SS)
NEW CONSTRUCTION
REGION II
FIGURE 6.2a
C = 2.88 x 10^{6} Q$^{1.07}$
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M^{3}/DAY = MGD/0.264)

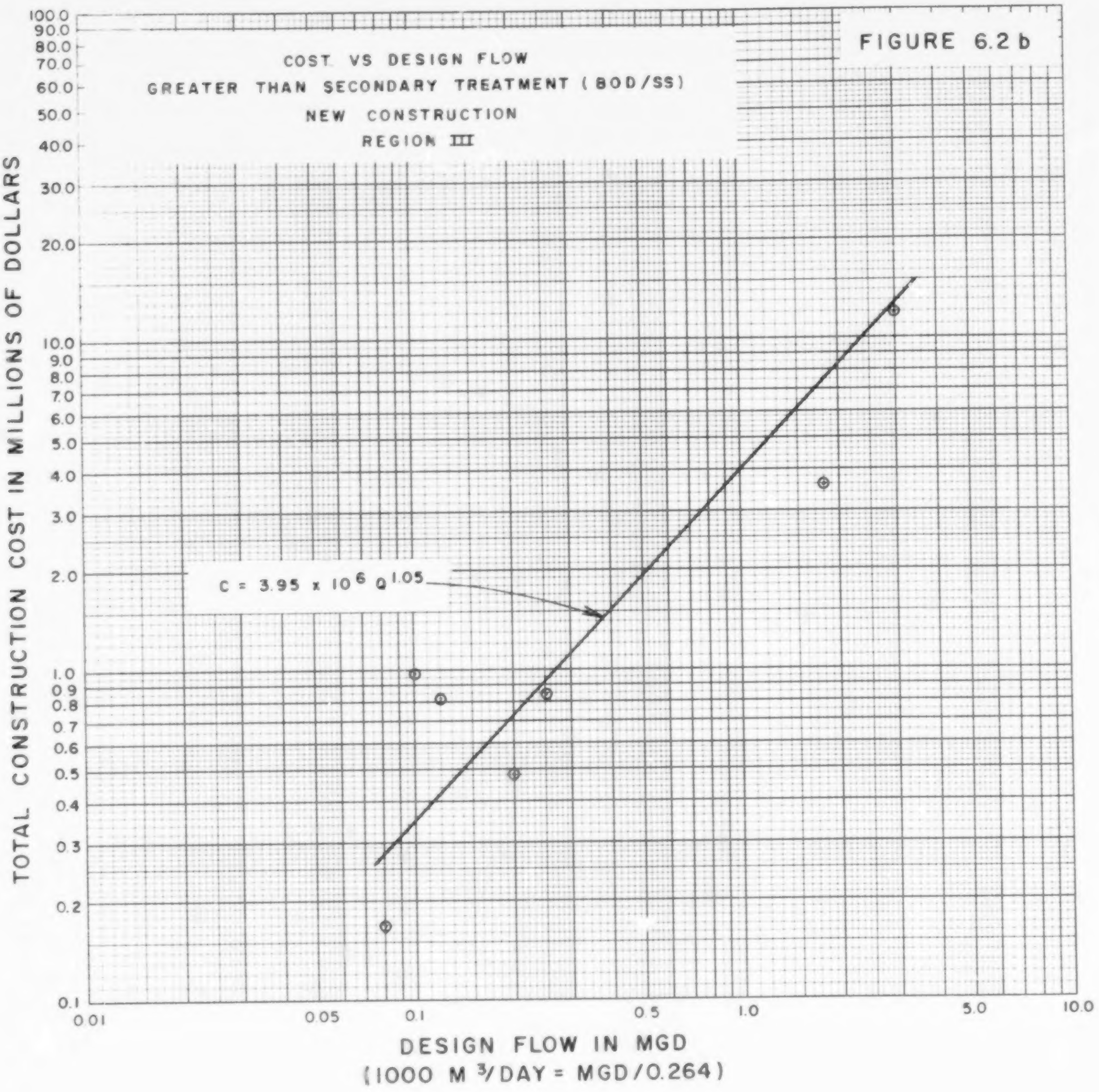


FIGURE 6.2 b

COST VS DESIGN FLOW
GREATER THAN SECONDARY TREATMENT (BOD/SS)
NEW CONSTRUCTION
REGION III

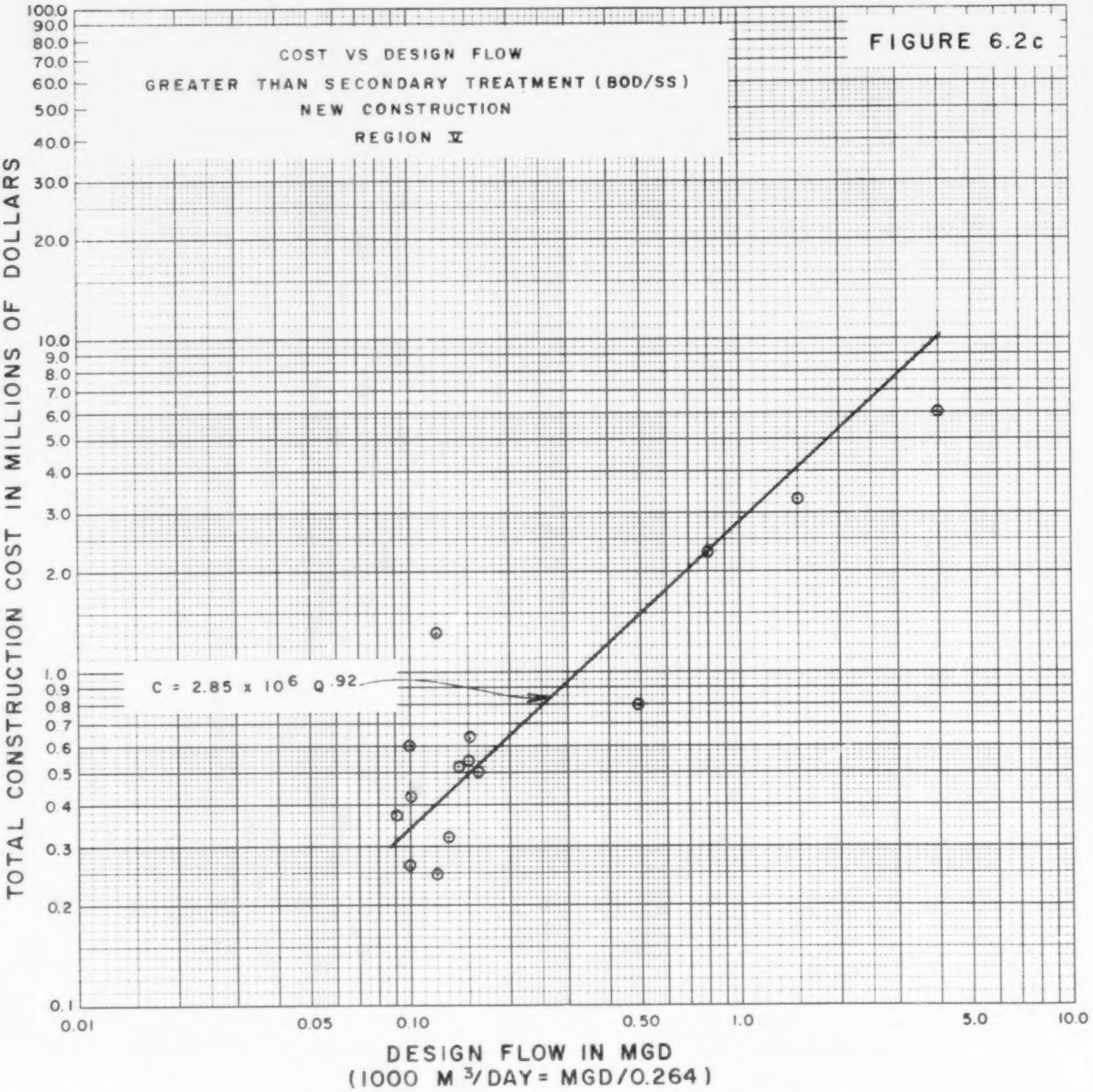


FIGURE 6.2c
COST VS DESIGN FLOW
GREATER THAN SECONDARY TREATMENT (BOD/SS)
NEW CONSTRUCTION
REGION V
C = 2.85 x 10^6 Q^.92
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01
0.05
0.10
0.50
1.0
5.0
10.0
DESIGN FLOW IN MGD
(1000 M 3/DAY = MGD/0.264)

TABLE 6.7

GREATER THAN SECONDARY - NEW CONSTRUCTION

Regional Data - Unplotted

Region	Grant No.	Design Flow (mgd)	Cost ($)
I	440086	3.50	7,657,858
IV	370382	24.00	29,477,613
	370434	1.50	2,094,140
	450265	.30	385,155
VI	400682	.75	732,994
	480981	.25	293,998
VII	200576	.14	254,078
VIII	490142	2.26	2,699,619
	490152	.88	1,452,267
IX	040134	1.50	1,636,962
	060810	10.35	36,806,755
X	410416	.04	443,469
	530549	.06	1,845,667

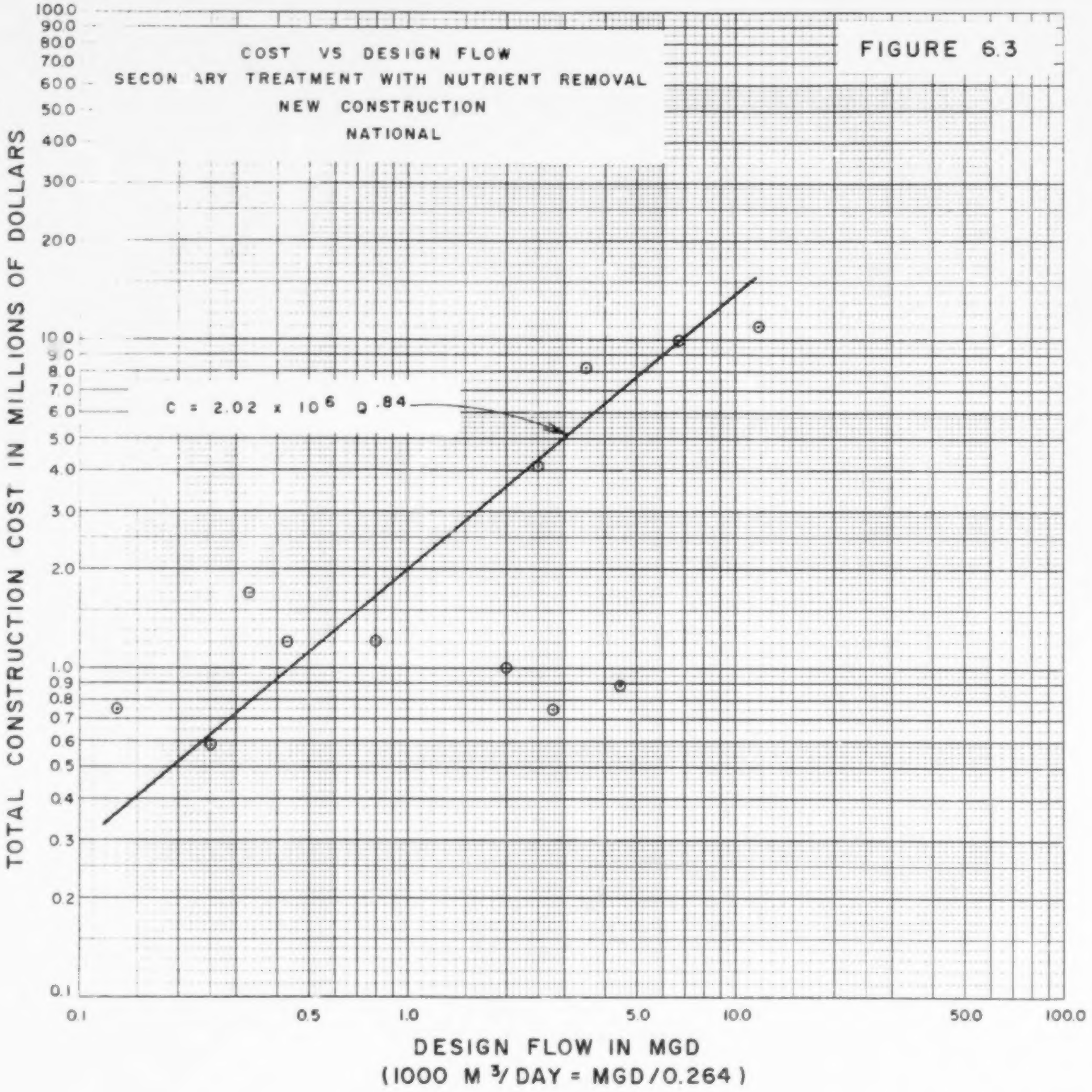


FIGURE 6.3

COST VS DESIGN FLOW
SECONDARY TREATMENT WITH NUTRIENT REMOVAL
NEW CONSTRUCTION
NATIONAL

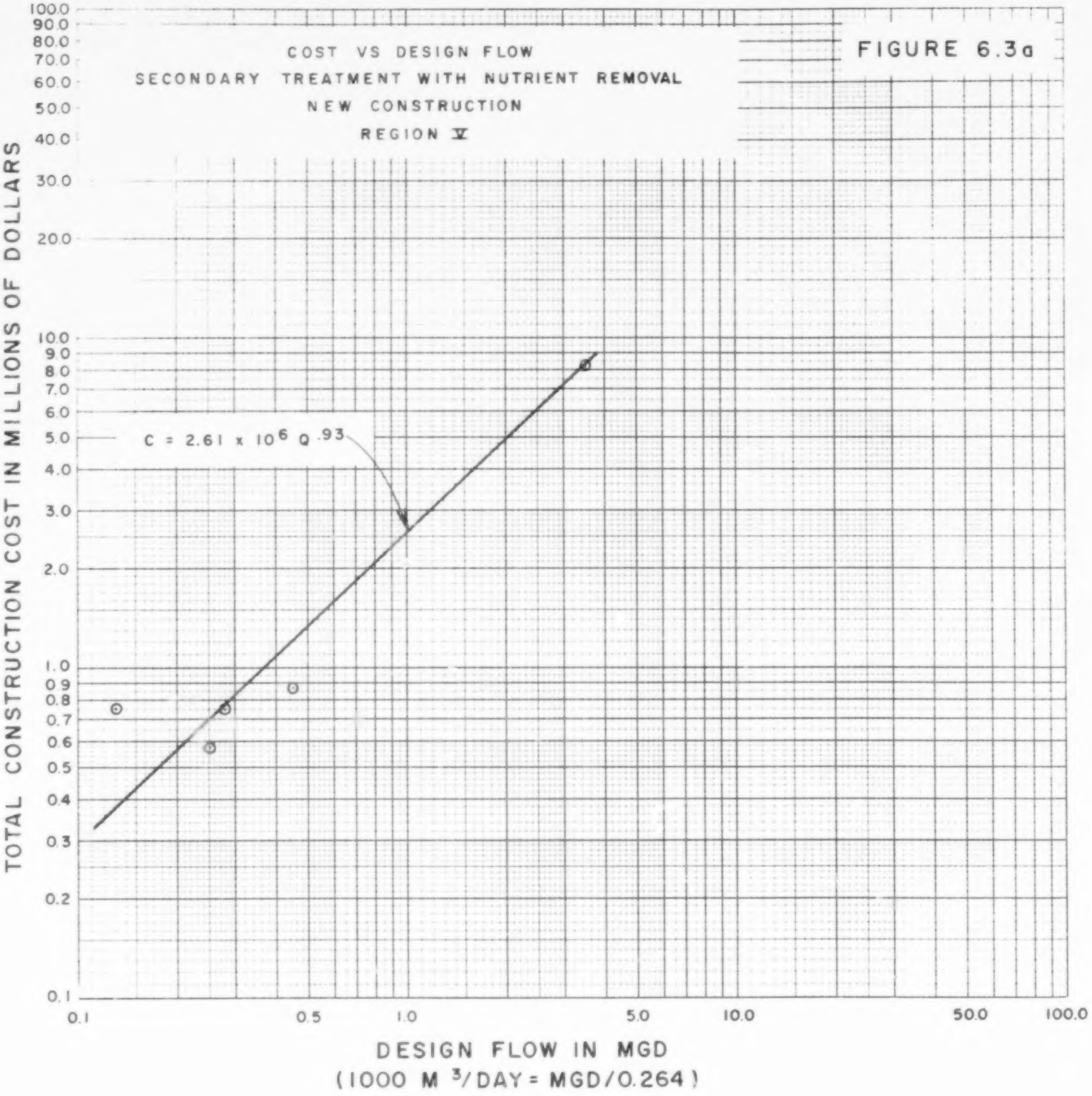


FIGURE 6.3a
COST VS DESIGN FLOW
SECONDARY TREATMENT WITH NUTRIENT REMOVAL
NEW CONSTRUCTION
REGION V
$C = 2.61 \times 10^6 Q^{.93}$
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M 3/DAY = MGD/0.264)

TABLE 6.8

SECONDARY WITH NUTRIENT REMOVAL - NEW CONSTRUCTION

Regional Data - Unplotted

Region	Grant No.	Design Flow (mgd)	Cost ($)
I	330203	11.54	10,980,074
II	340358	2.50	4,094,405
III	420742 420917	.33 .43	1,765,987 1,188,435
IV	370441	6.70	10,117,877
VI	400648	2.00	1,055,819
VII	290674	.80	1,263,201

Note: Cost data for wastewater treatment plants in this category were not available for Regions VIII, IX and X.

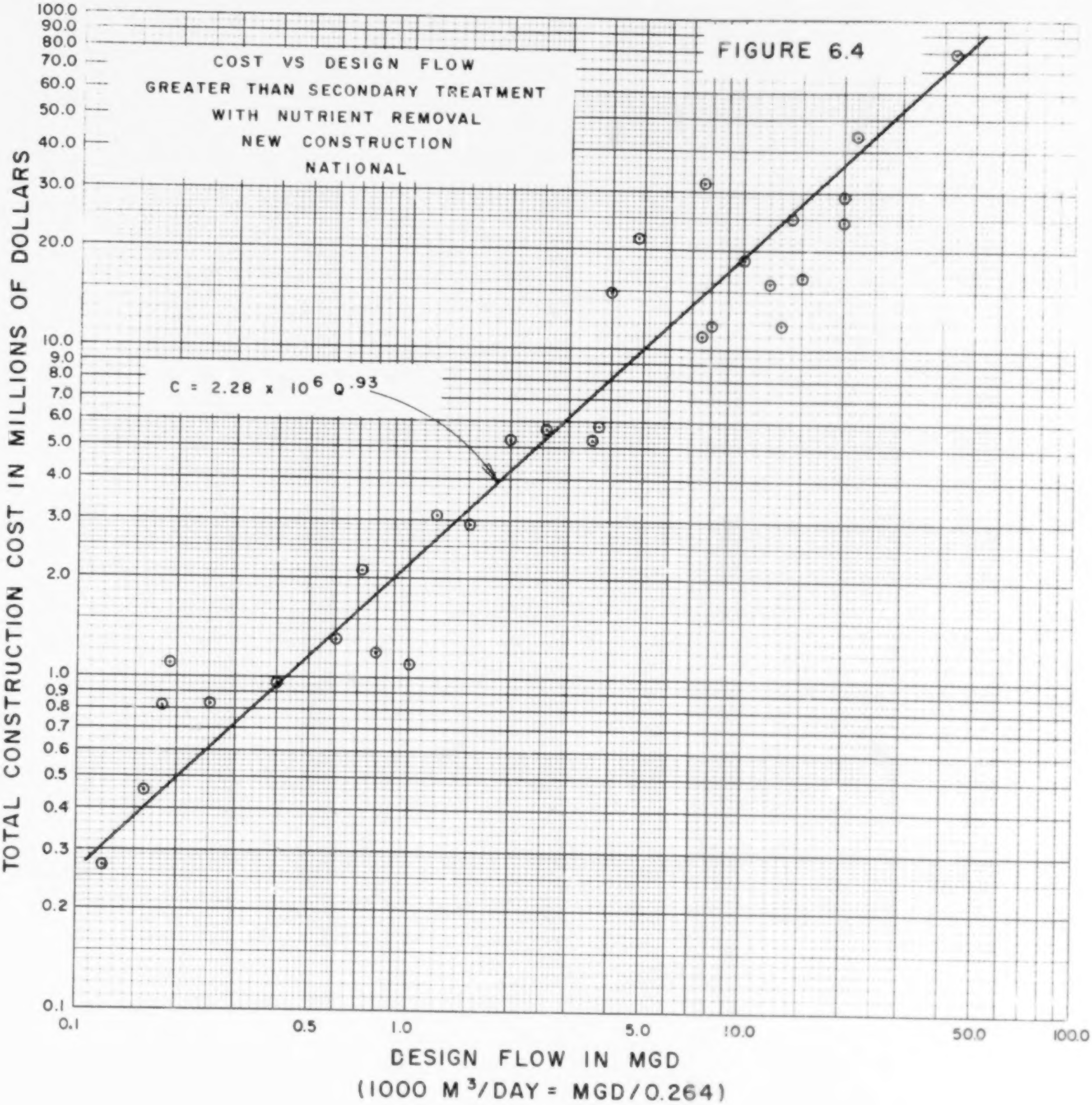


FIGURE 6.4

COST VS DESIGN FLOW
GREATER THAN SECONDARY TREATMENT
WITH NUTRIENT REMOVAL
NEW CONSTRUCTION
NATIONAL

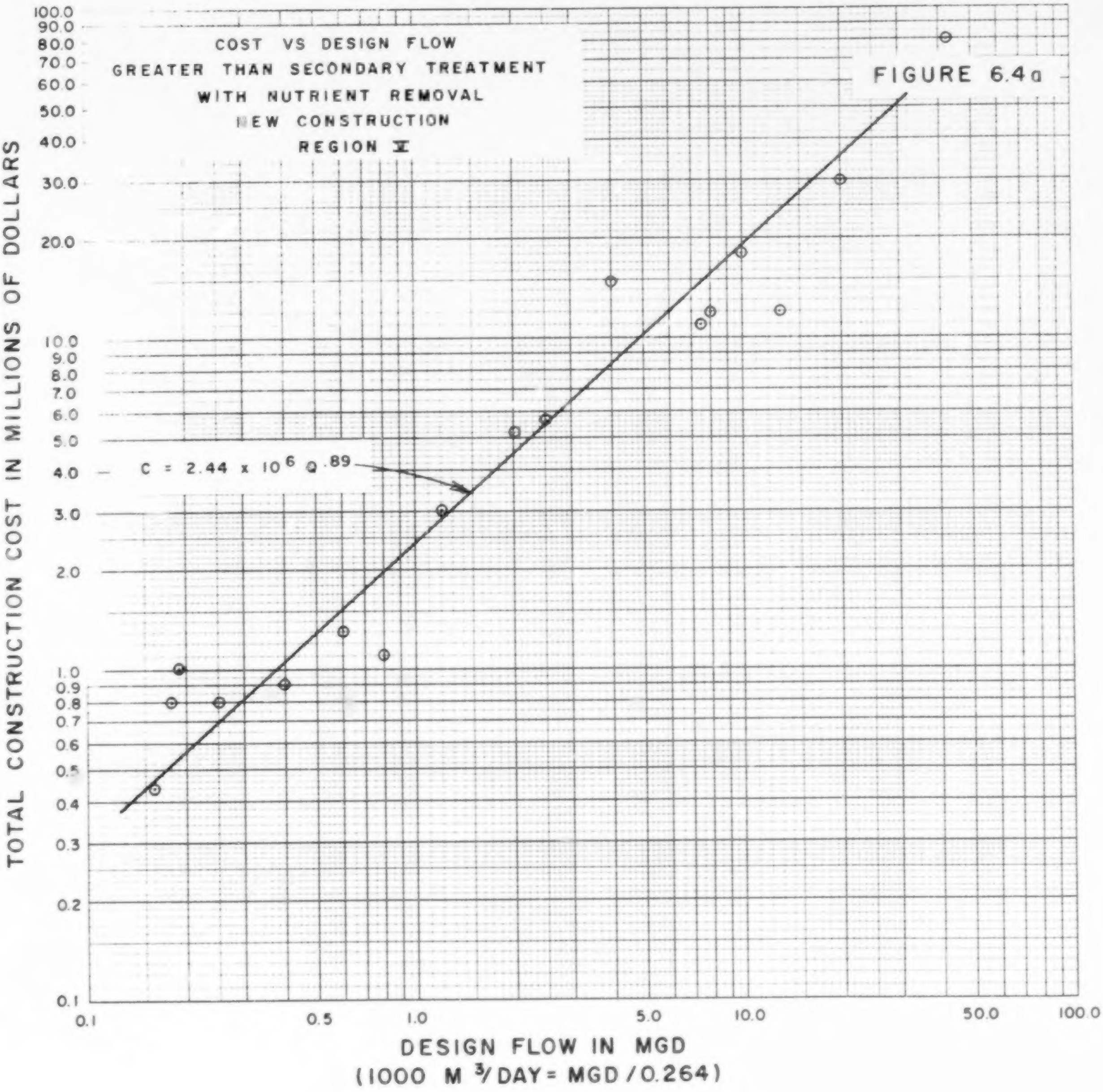


FIGURE 6.4a

COST VS DESIGN FLOW
GREATER THAN SECONDARY TREATMENT
WITH NUTRIENT REMOVAL
NEW CONSTRUCTION
REGION V
$C = 2.44 \times 10^6 Q^{.89}$
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M 3/DAY = MGD/0.264)

TABLE 6.9

GREATER THAN SECONDARY WITH NUTRIENT REMOVAL - NEW CONSTRUCTION
Regional Data - Unplotted

Region	Grant No.	Design Flow (mgd)	Cost ($)
II	340354	7.50	31,620,334
	360707	14.10	26,548,399
III	510331	22.50	45,663,989
IV	010250	1.00	1,131,055
	370383	3.50	5,323,869
VI	050305	12.00	15,992,658
	050350	.12	270,661
VII	190605	.72	2,108,891
	190637	3.70	5,893,281
VIII	080322	1.50	2,937,457
IX	061121	4.83	22,133,369
X	410371	20.00	25,765,275
	410485	15.00	17,132,645

Note: Cost data for wastewater treatment plants in this category were not available for Region I.

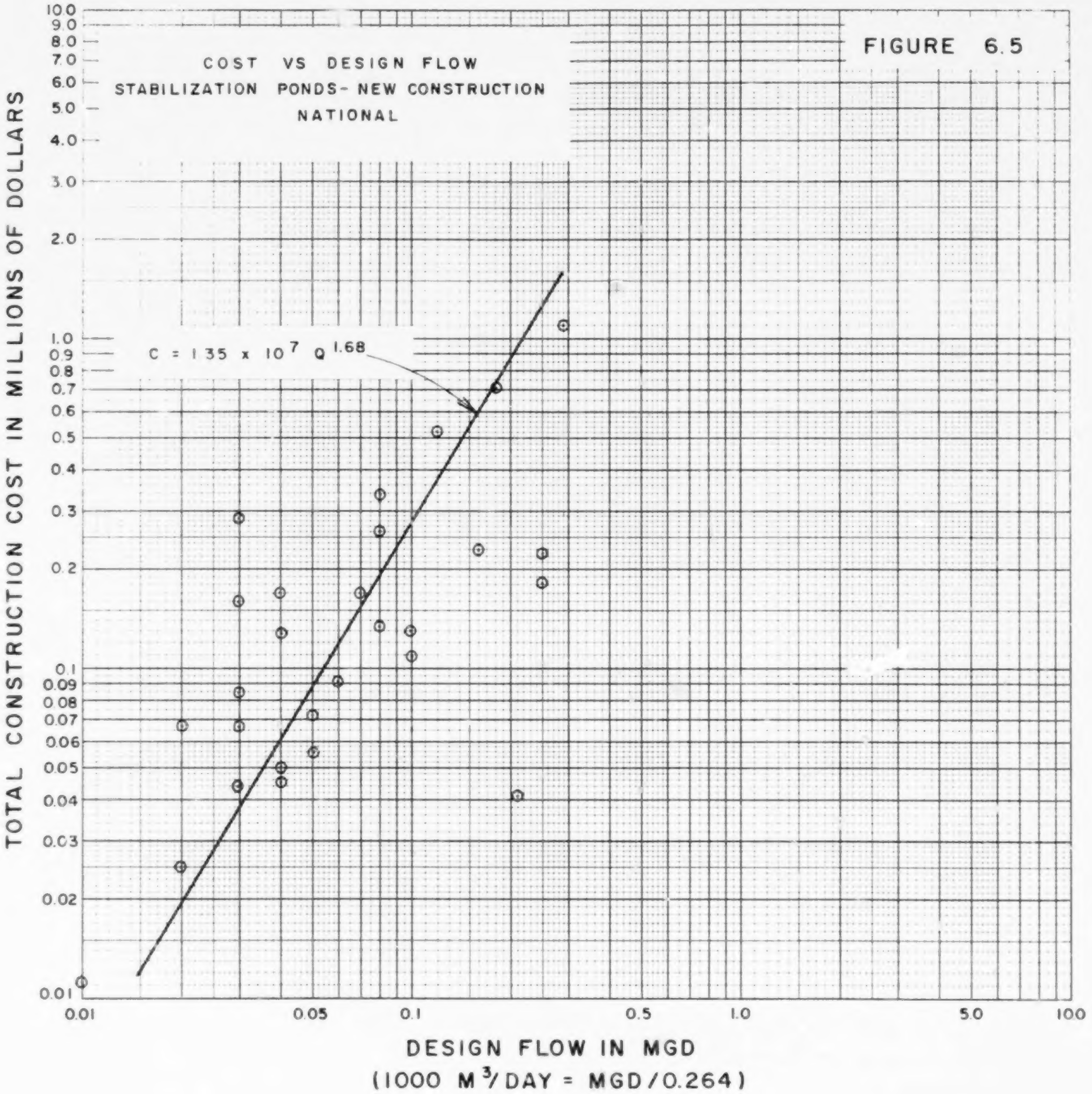
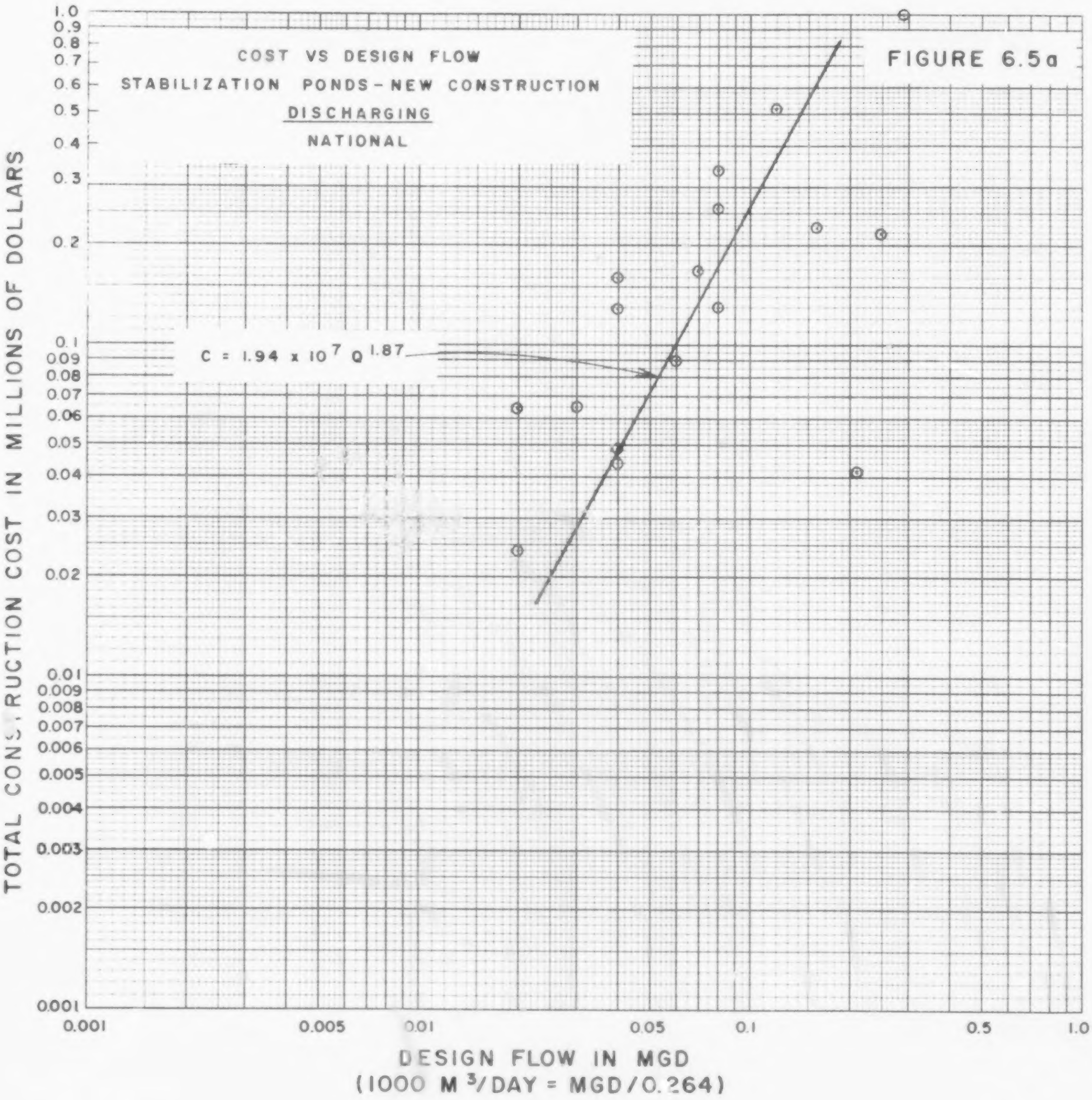
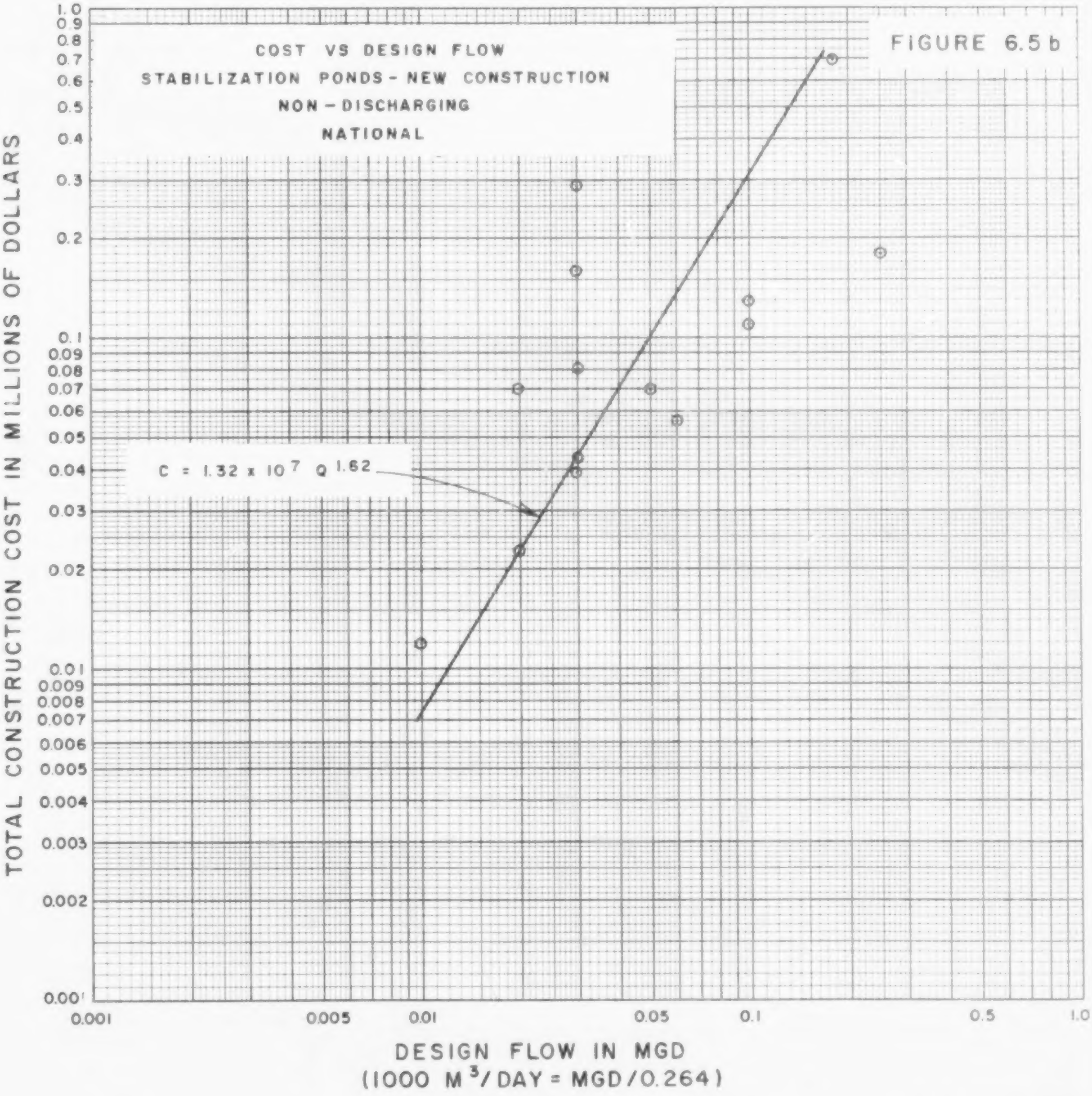


FIGURE 6.5

COST VS DESIGN FLOW
STABILIZATION PONDS- NEW CONSTRUCTION
NATIONAL


COST VS DESIGN FLOW
STABILIZATION PONDS - NEW CONSTRUCTION
DISCHARGING
NATIONAL
FIGURE 6.5a
$C = 1.94 \times 10^{7} Q^{1.87}$
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.001
0.005
0.01
0.05
0.1
0.5
1.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)


COST VS DESIGN FLOW
STABILIZATION PONDS - NEW CONSTRUCTION
NON - DISCHARGING
NATIONAL
FIGURE 6.5 b
C = 1.32 x 10^7 Q^1.62
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.001
0.005
0.01
0.05
0.1
0.5
1.0
DESIGN FLOW IN MGD
(1000 M³/ DAY = MGD/0.264)

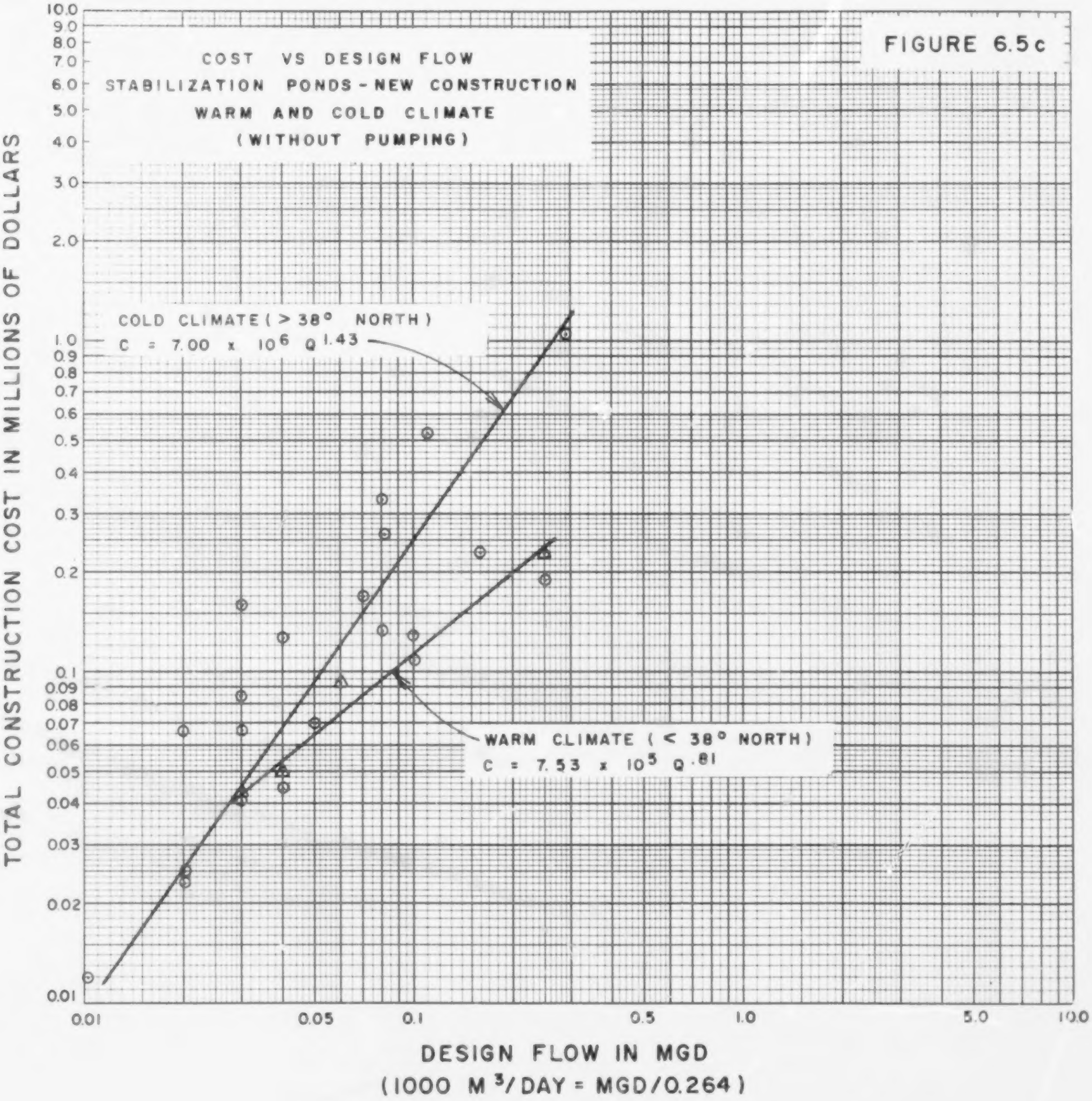


FIGURE 6.5c

COST VS DESIGN FLOW
STABILIZATION PONDS - NEW CONSTRUCTION
WARM AND COLD CLIMATE
(WITHOUT PUMPING)

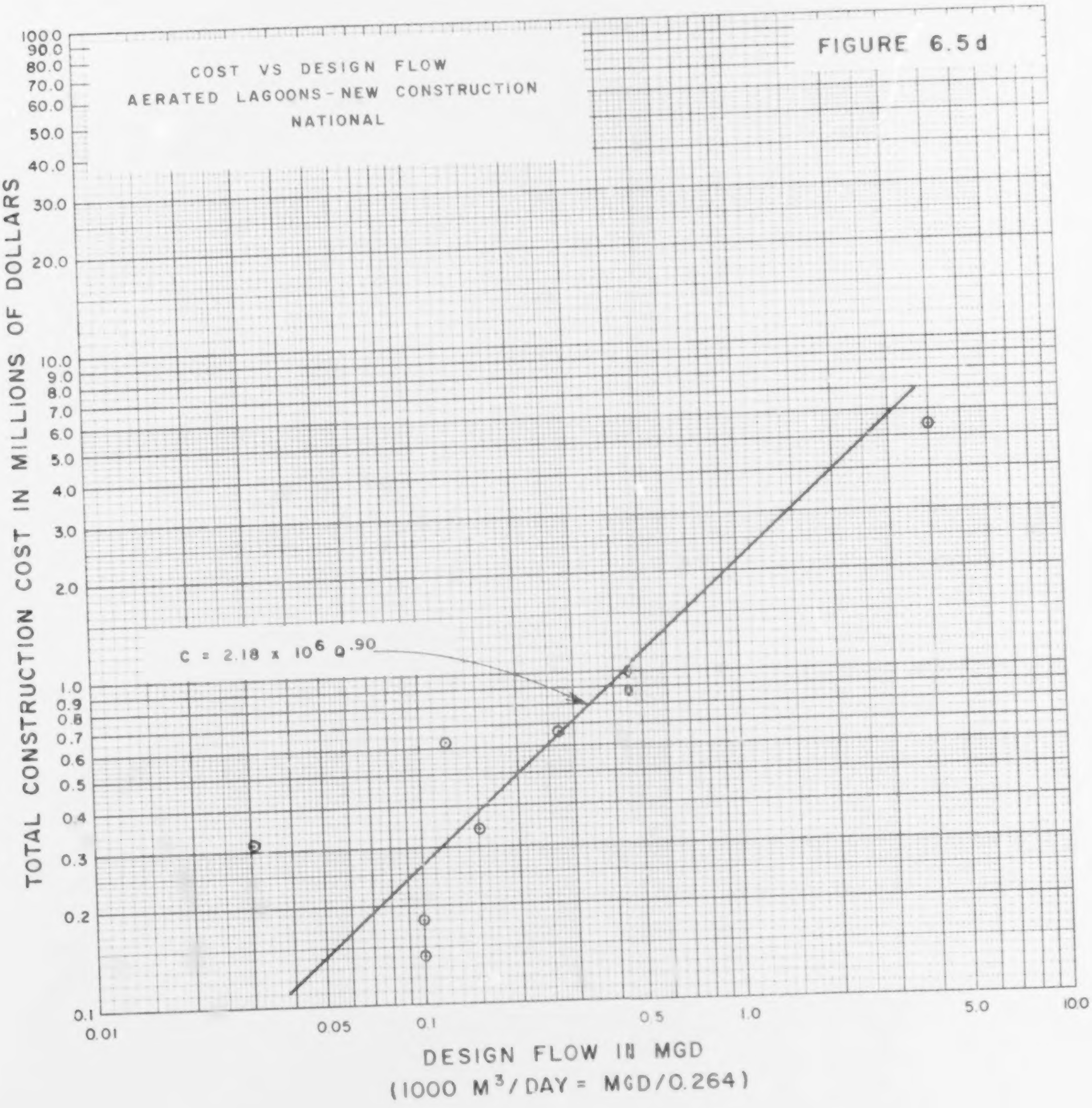


FIGURE 6.5d
COST VS DESIGN FLOW
AERATED LAGOONS - NEW CONSTRUCTION
NATIONAL
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
$C = 2.18 \times 10^6 Q^{.90}$
0.01
0.05
0.1
0.5
1.0
5.0
10.0
DESIGN FLOW IN MGD
(1000 M^3/DAY = MGD/0.264)

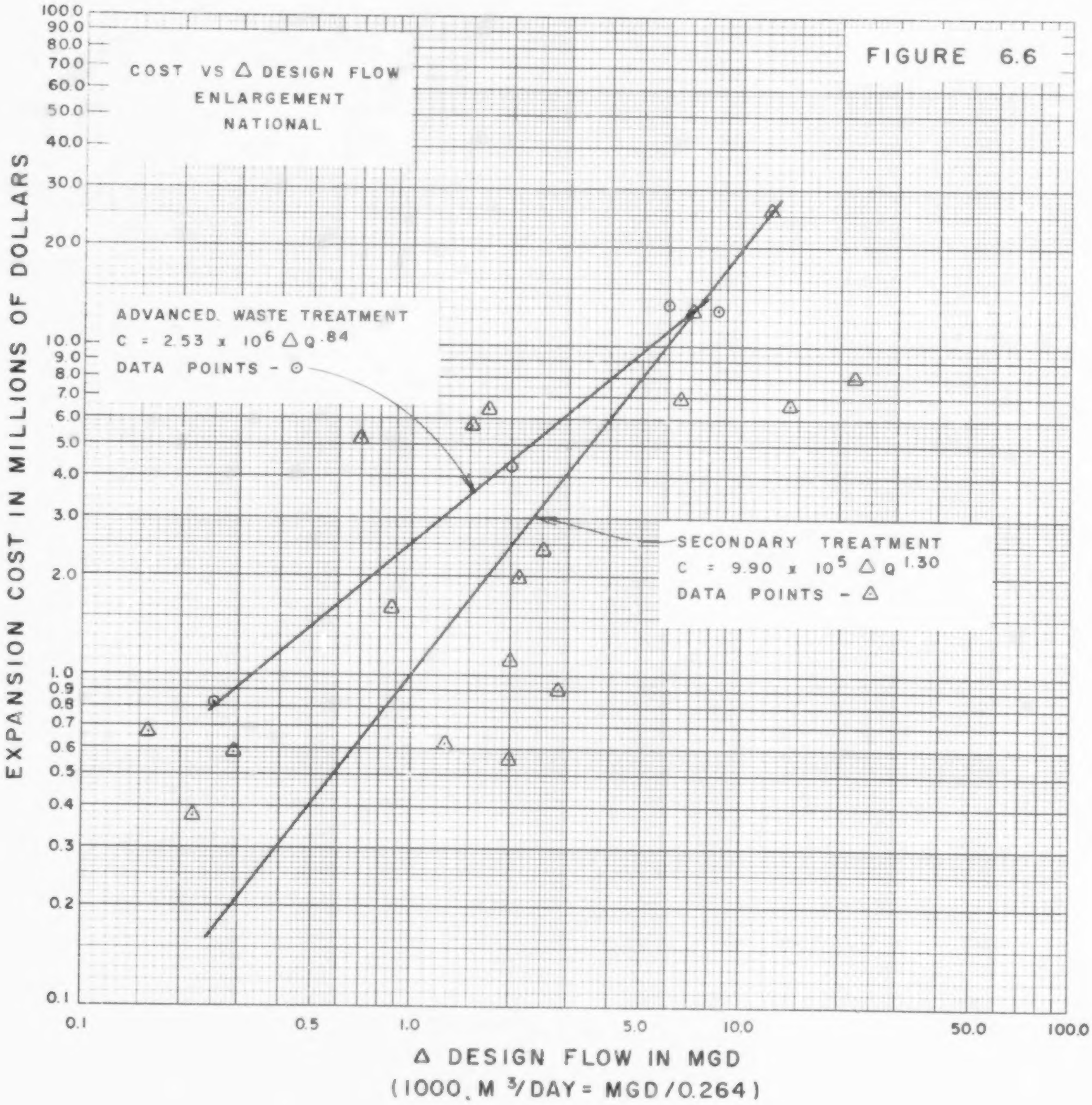


FIGURE 6.6
COST VS Δ DESIGN FLOW
ENLARGEMENT
NATIONAL
ADVANCED WASTE TREATMENT
C = 2.53 x 10^6 ΔQ^.84
DATA POINTS - ⊙
SECONDARY TREATMENT
C = 9.90 x 10^5 ΔQ^1.30
DATA POINTS - △
EXPANSION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
Δ DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

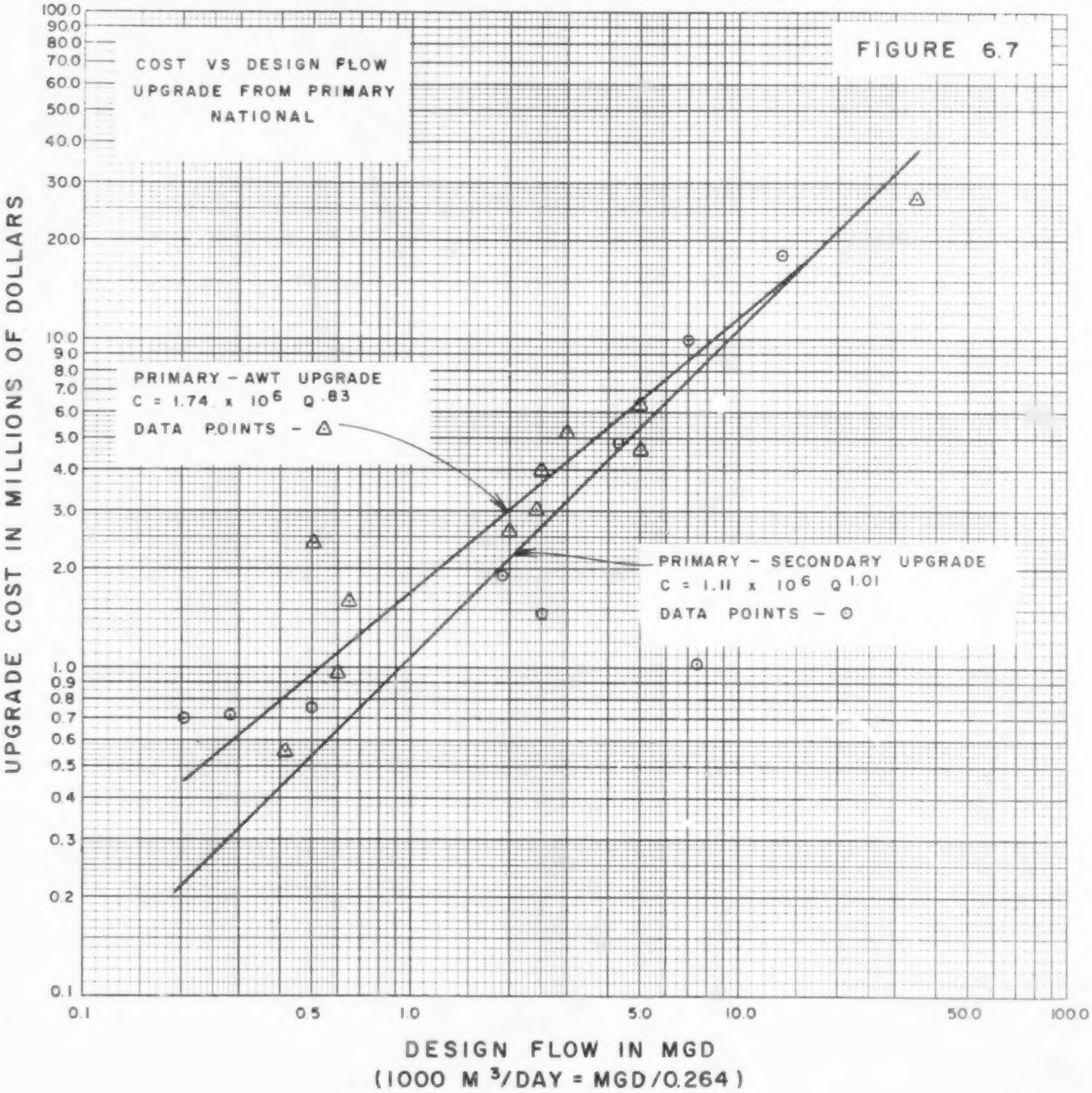


FIGURE 6.7

COST VS DESIGN FLOW
UPGRADE FROM PRIMARY
NATIONAL

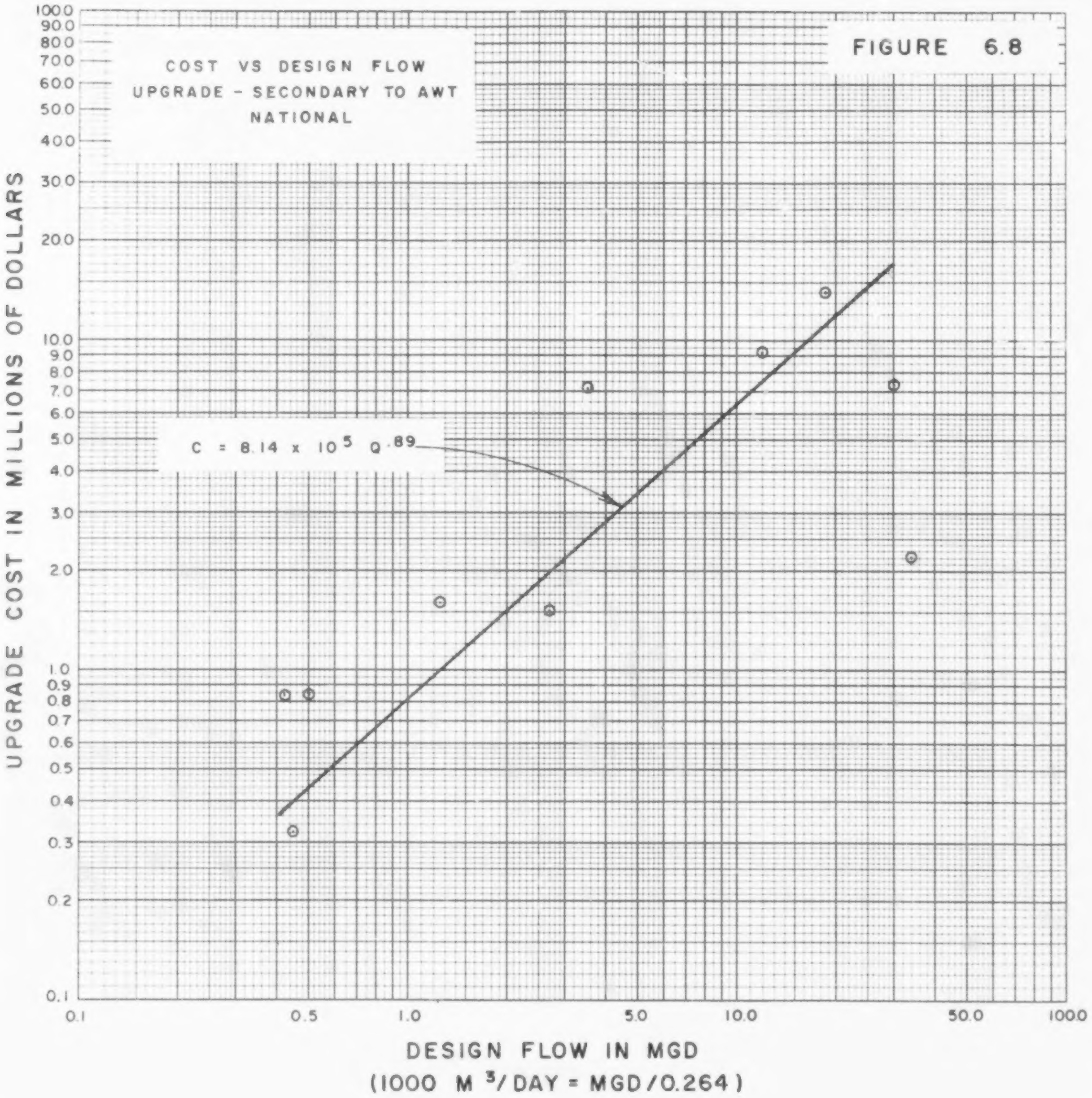

COST VS DESIGN FLOW
UPGRADE – SECONDARY TO AWT
NATIONAL
FIGURE 6.8
C = 8.14 x 10⁵ Q.89
UPGRADE COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

FIGURE 6.9

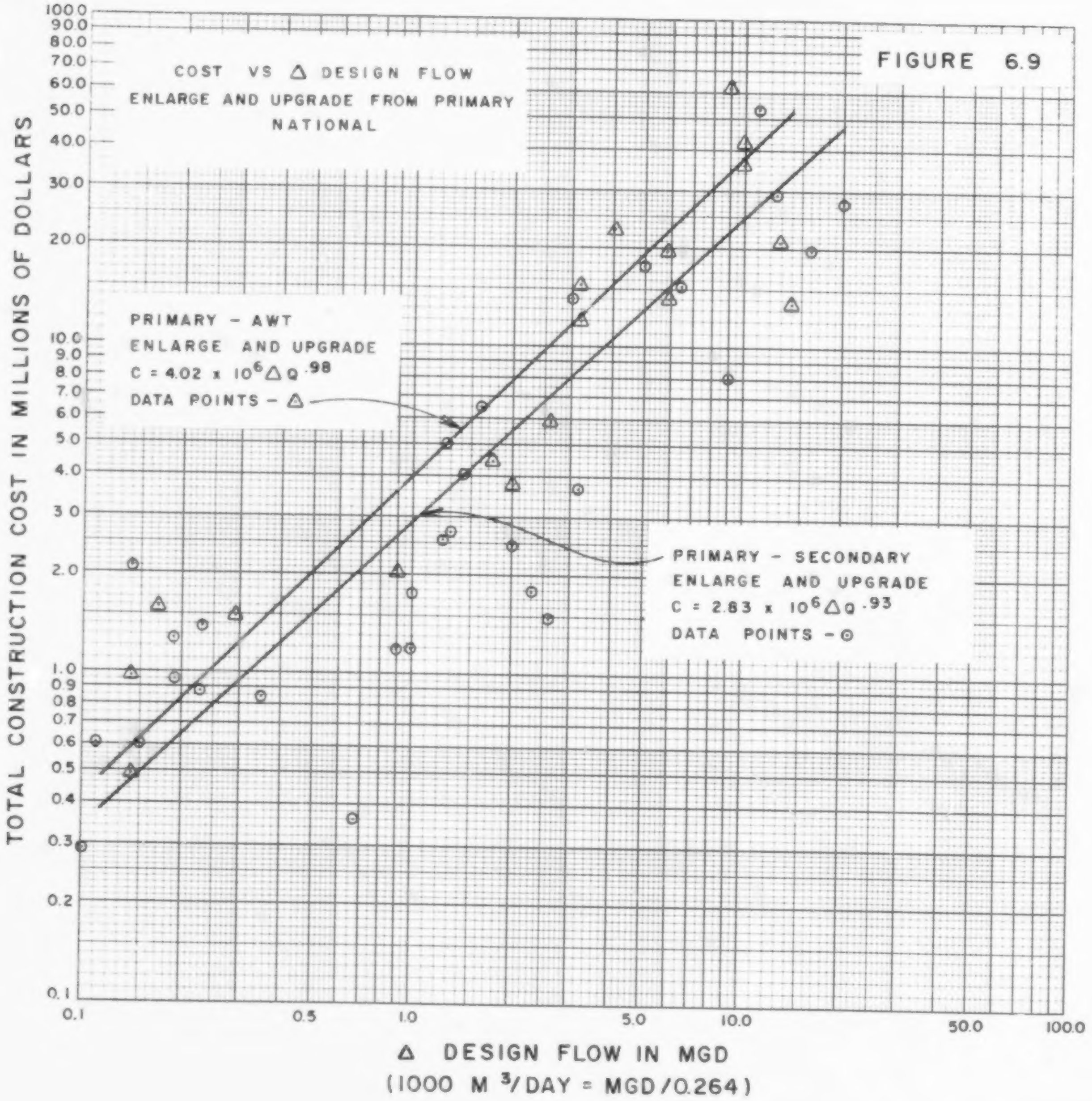
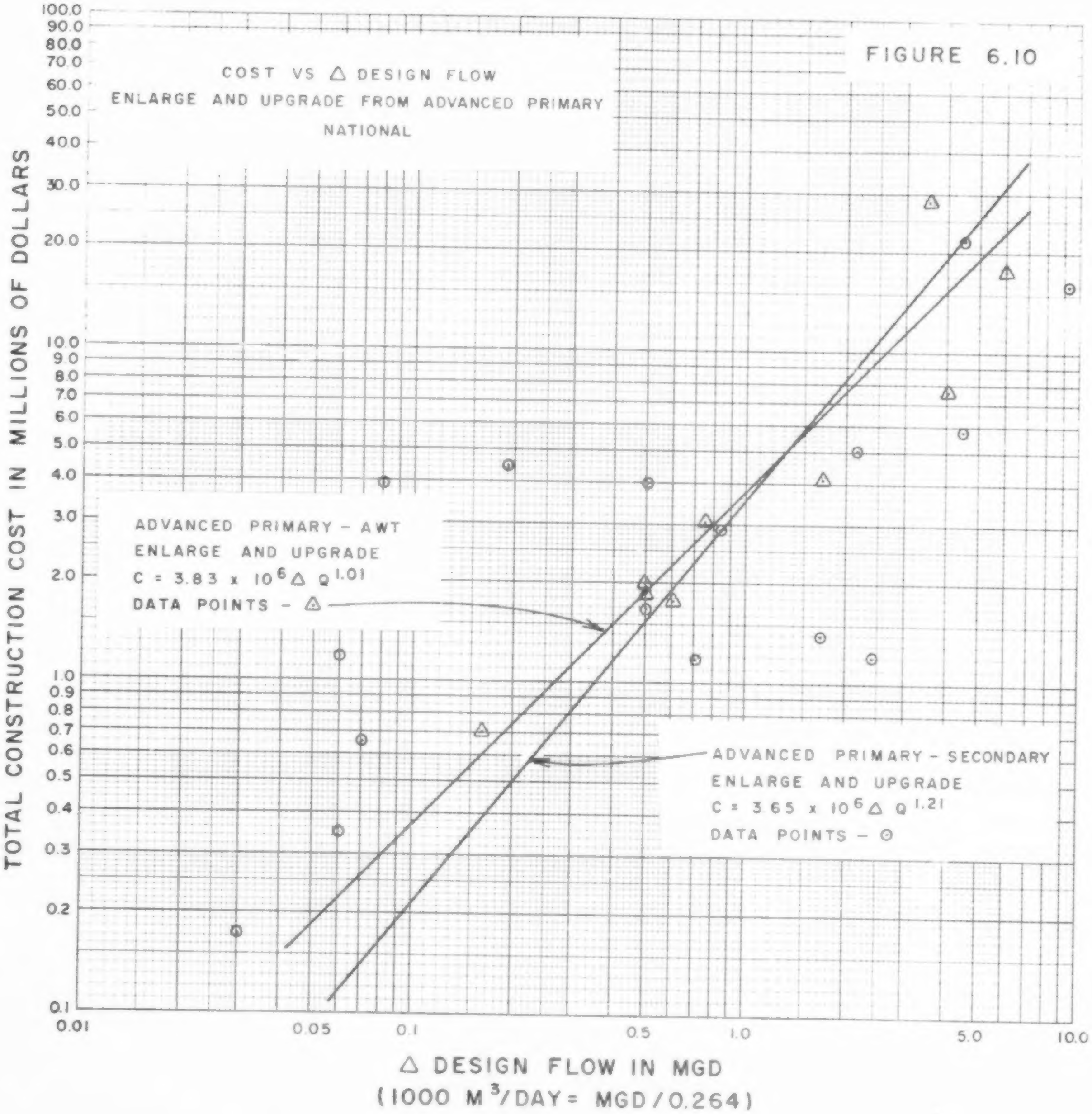

COST VS △ DESIGN FLOW
ENLARGE AND UPGRADE FROM PRIMARY
NATIONAL
PRIMARY - AWT
ENLARGE AND UPGRADE
C = 4.02 x 10^6△Q$^{.98}$
DATA POINTS - △
PRIMARY - SECONDARY
ENLARGE AND UPGRADE
C = 2.83 x 10^6△Q$^{.93}$
DATA POINTS - ⊙
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
△ DESIGN FLOW IN MGD
(1000 M ^{3}/DAY = MGD/0.264)

FIGURE 6.10



COST VS Δ DESIGN FLOW
ENLARGE AND UPGRADE FROM ADVANCED PRIMARY
NATIONAL

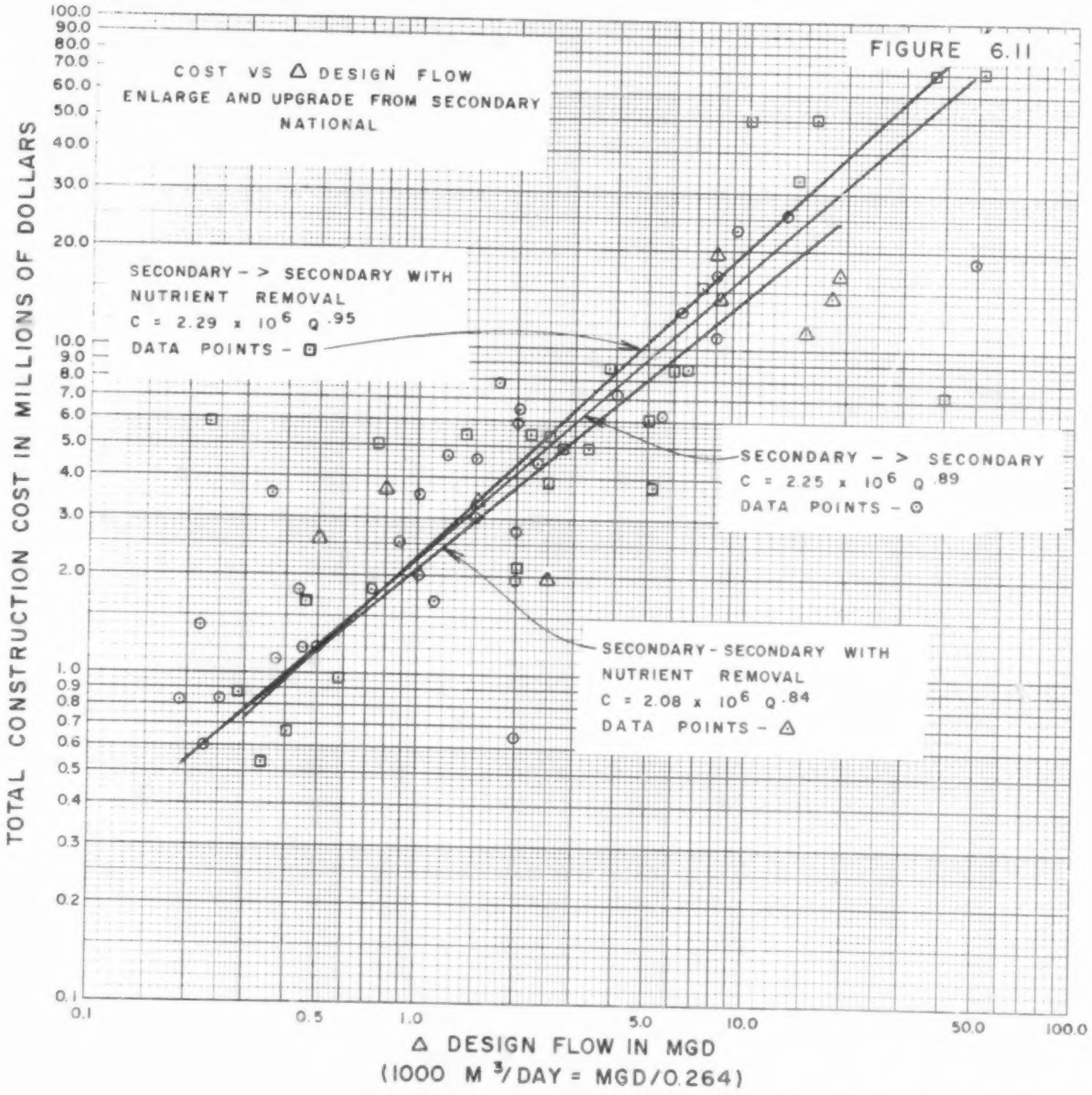


FIGURE 6.11

COST VS Δ DESIGN FLOW
ENLARGE AND UPGRADE FROM SECONDARY
NATIONAL

SECOND ORDER COST CURVES

(UNIT PROCESS COSTS)

TABLE 6.10

Unit Processes - Water Stream

Process	Equation
Preliminary Treatment	$C = 5.79 \times 10^4 Q^{1.17}$
Influent Pumping	$C = 1.47 \times 10^5 Q^{1.03}$
Flow Equalization	$C = 1.09 \times 10^5 Q^{0.49}$
Primary Sedimentation	$C = 6.94 \times 10^4 Q^{1.04}$
Trickling Filter	
Activated Sludge	$C = 2.27 \times 10^5 Q^{0.87}$
Oxygen Activated Sludge	
Rotating Biological Contactor	$C = 3.19 \times 10^5 Q^{0.92}$
Biological Filter	
Other Treatment	
Filtration	$C = 1.85 \times 10^5 Q^{0.84}$
Clarification	$C = 1.09 \times 10^5 Q^{1.01}$
Chemical Addition	$C = 2.36 \times 10^4 Q^{1.68}$
Activated Carbon Adsorption	
Biological Nitrification	
Biological Denitrification	
Ion Exchange	
Breakpoint Chlorination	
Ammonia Stripping	
Stabilization Pond	$C = 9.05 \times 10^5 Q^{1.27}$
Aerated Lagoon	$C = 3.35 \times 10^5 Q^{1.13}$
Chlorination	$C = 5.27 \times 10^4 Q^{0.97}$
Ozonization	
Other Disinfection	
Post Aeration	
Land Treatment of Effluent	$C = 3.67 \times 10^5 Q^{1.02}$
Outfall Pumping	$C = 3.32 \times 10^4 Q^{1.26}$
Effluent Outfall	$C = 7.39 \times 10^4 Q^{1.37}$
Outfall Diffuser	$C = 3.24 \times 10^4 Q^{0.91}$
Other Processes	
Laboratory/Maintenance Building	$C = 1.65 \times 10^5 Q^{1.02}$

TABLE 6.10 - (continued)

Unit Processes - Sludge Stream

Process	Cost Equation
Gravity Thickening	$C = 3.28 \times 10^4 Q^{1.10}$
Flotation Thickening	$C = 2.99 \times 10^4 Q^{1.14}$
Other Sludge Handling	$C = 4.26 \times 10^4 Q^{1.36}$
Aerobic Digestion	$C = 1.47 \times 10^5 Q^{1.14}$
Anaerobic Digestion	$C = 1.12 \times 10^5 Q^{1.12}$
Sludge Lagoons	
Land Spreading	
Ocean Dumping	
Heat Treatment	$C = 1.51 \times 10^5 Q^{0.81}$
Mechanical Dewatering	$C = 3.44 \times 10^4 Q^{1.61}$
Air Drying	$C = 9.89 \times 10^4 Q^{1.35}$
Incineration	$C = 8.77 \times 10^4 Q^{1.33}$
Landfill	

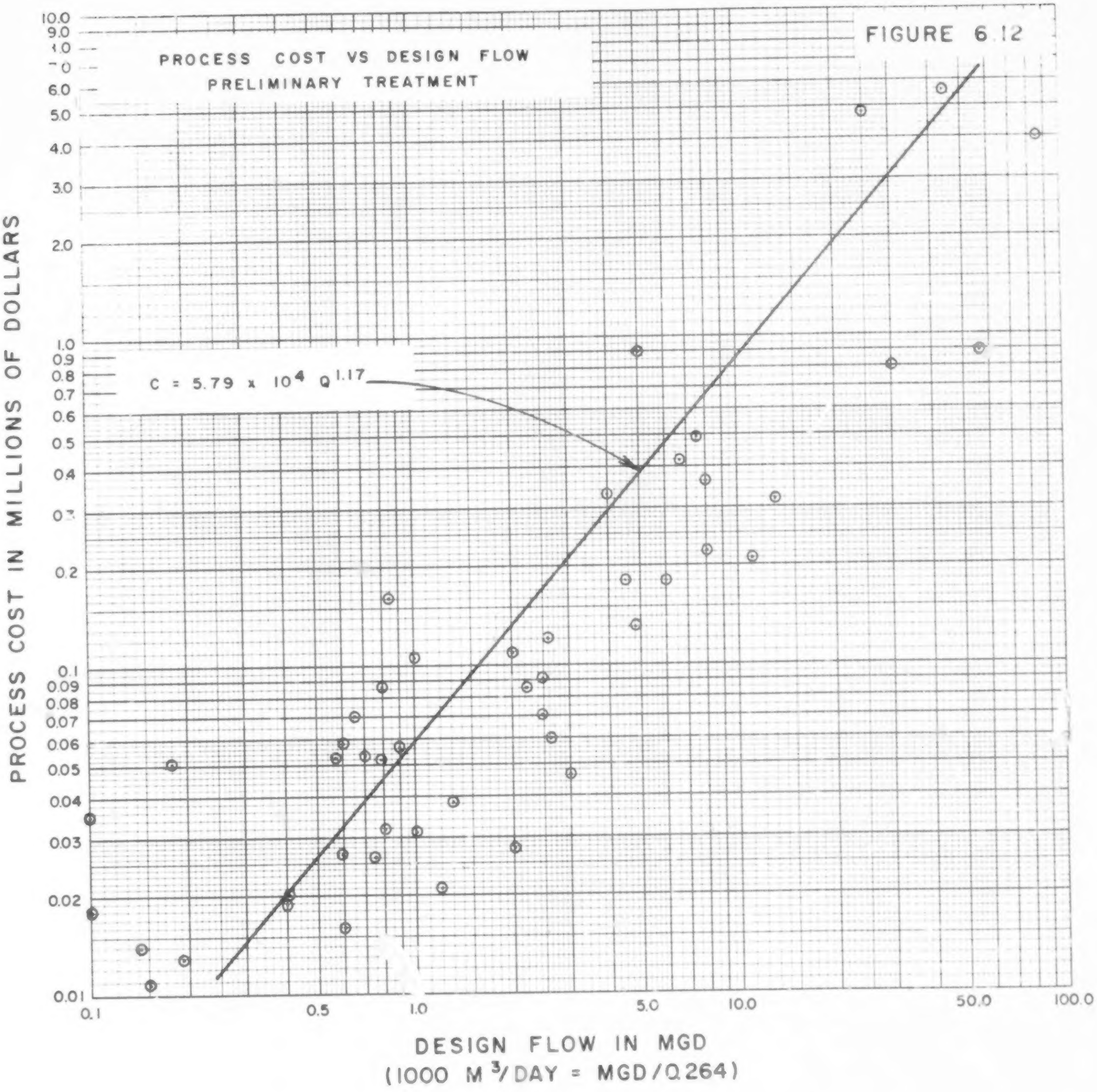


FIGURE 6.12

PROCESS COST VS DESIGN FLOW
PRELIMINARY TREATMENT

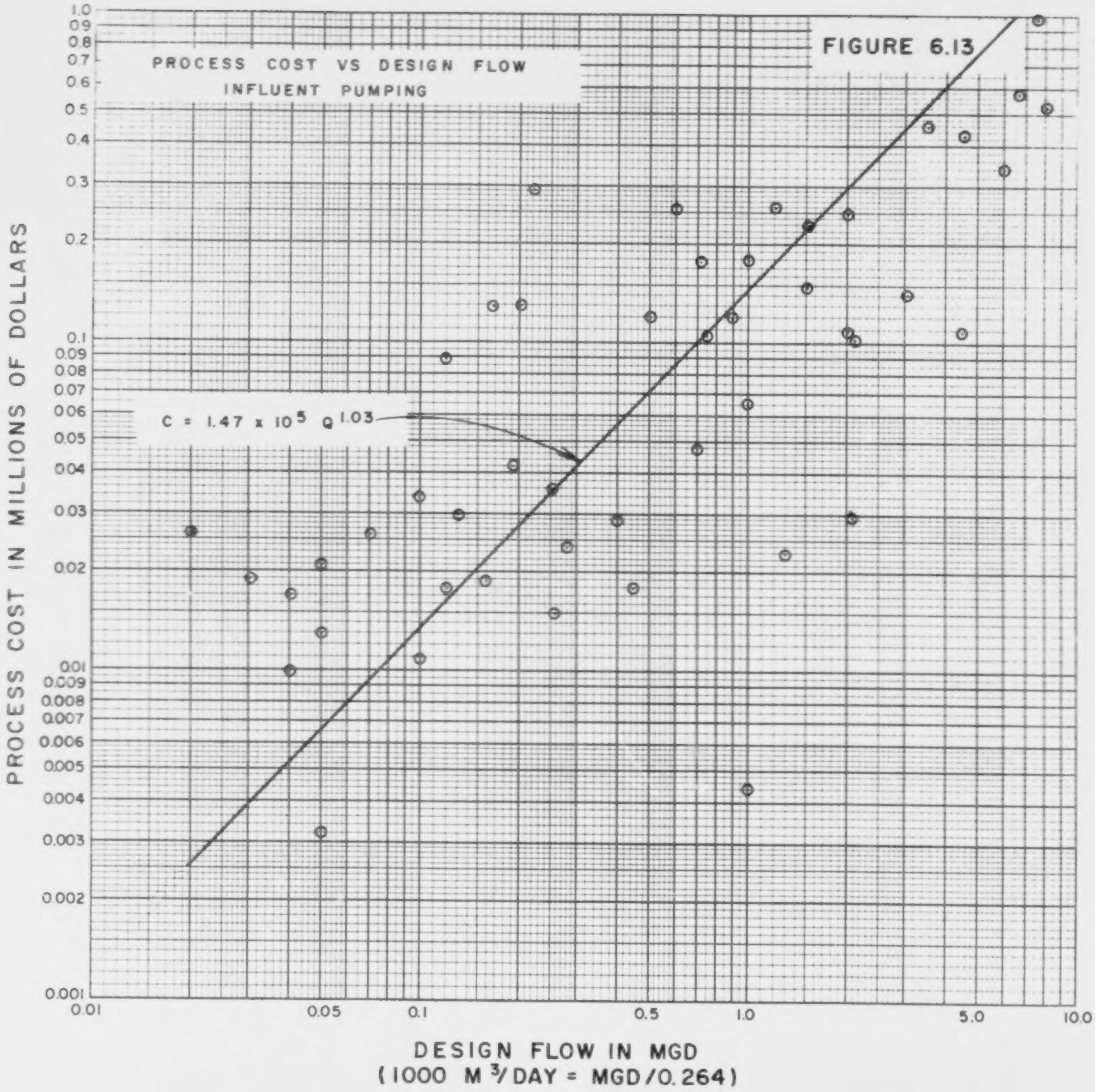


FIGURE 6.13
PROCESS COST VS DESIGN FLOW
INFLUENT PUMPING
C = 1.47 x 10^5 Q^1.03
PROCESS COST IN MILLIONS OF DOLLARS
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.01
0.05
0.1
0.5
1.0
5.0
10.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

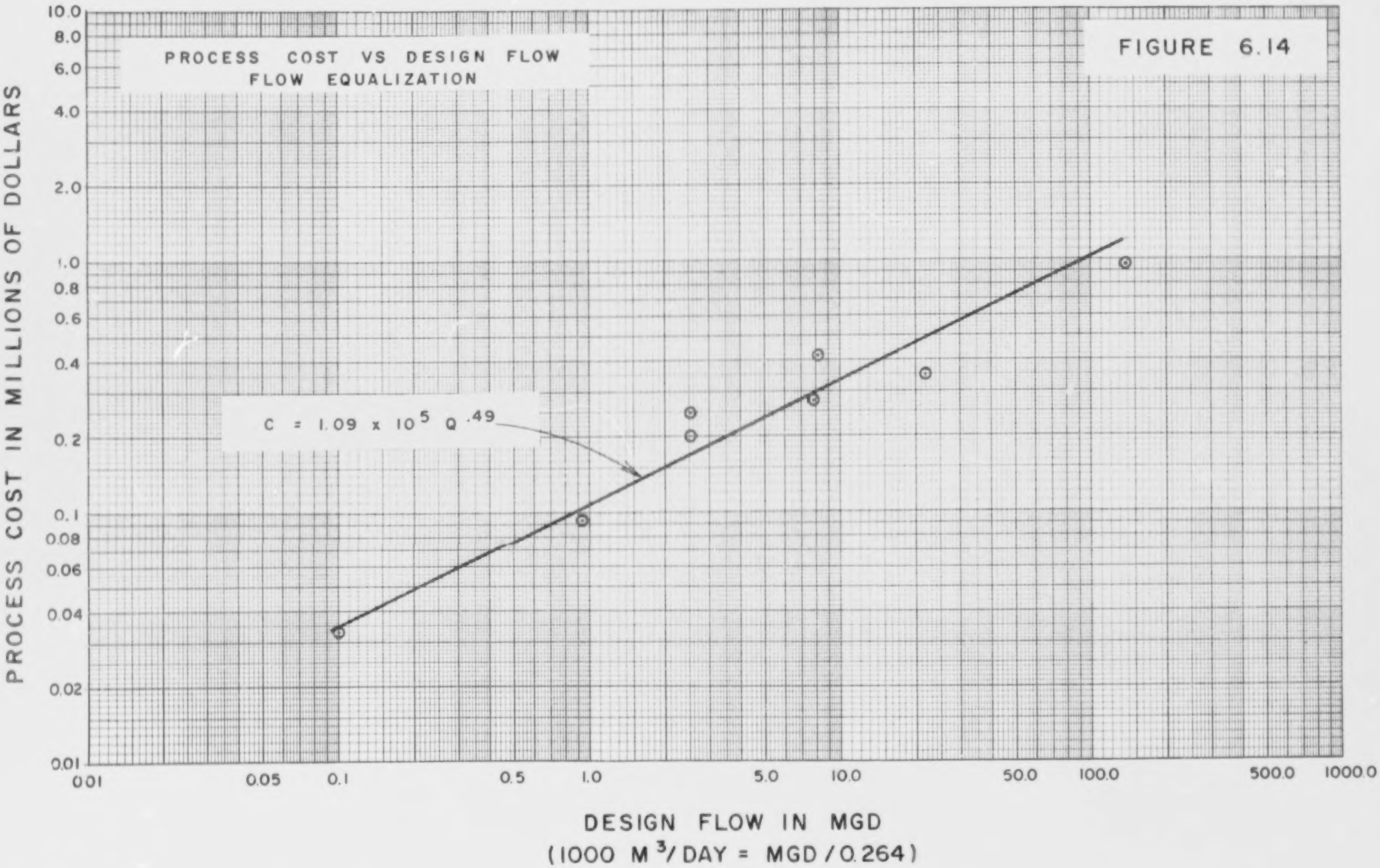


FIGURE 6.14

PROCESS COST VS DESIGN FLOW
FLOW EQUALIZATION

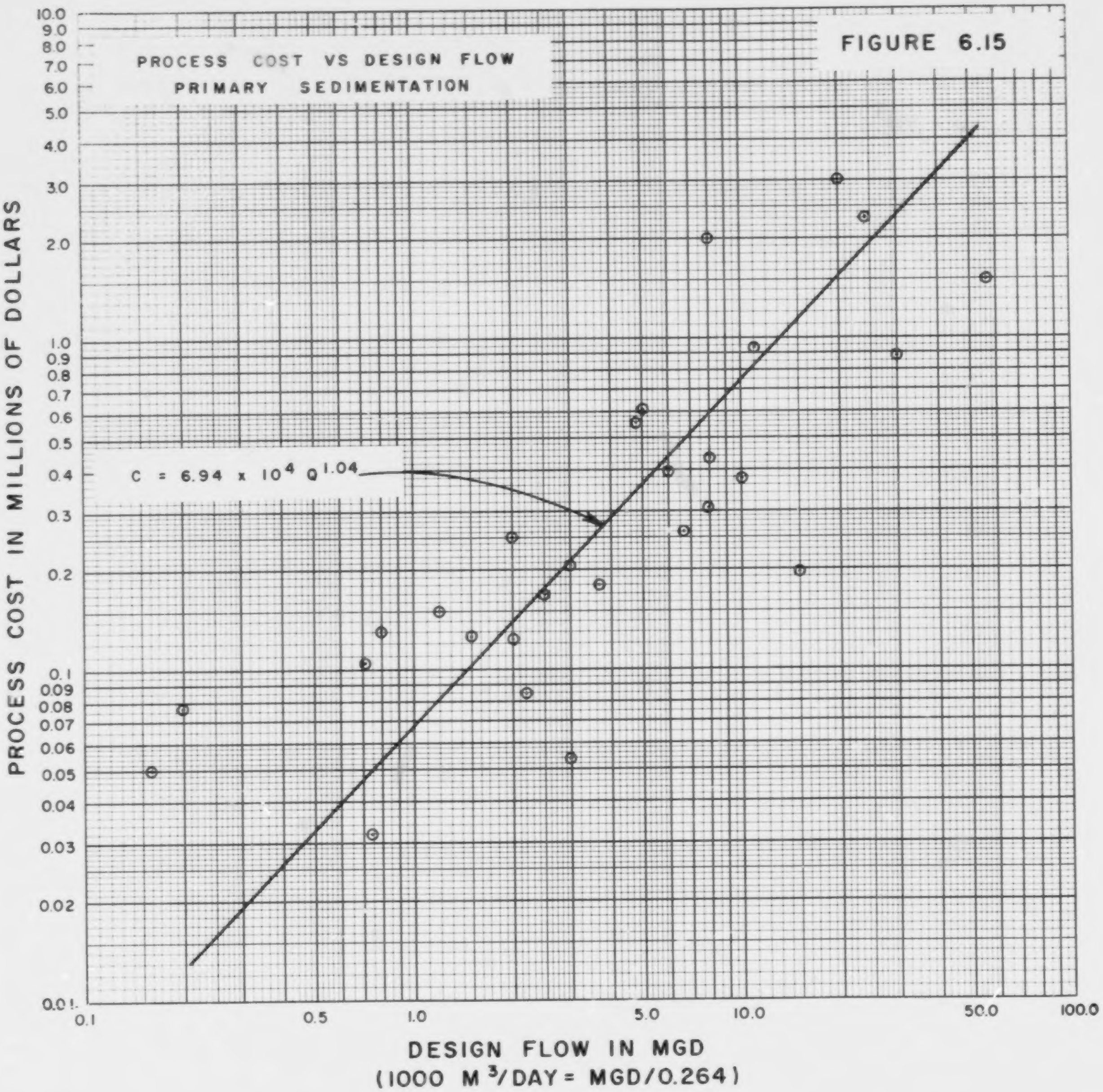
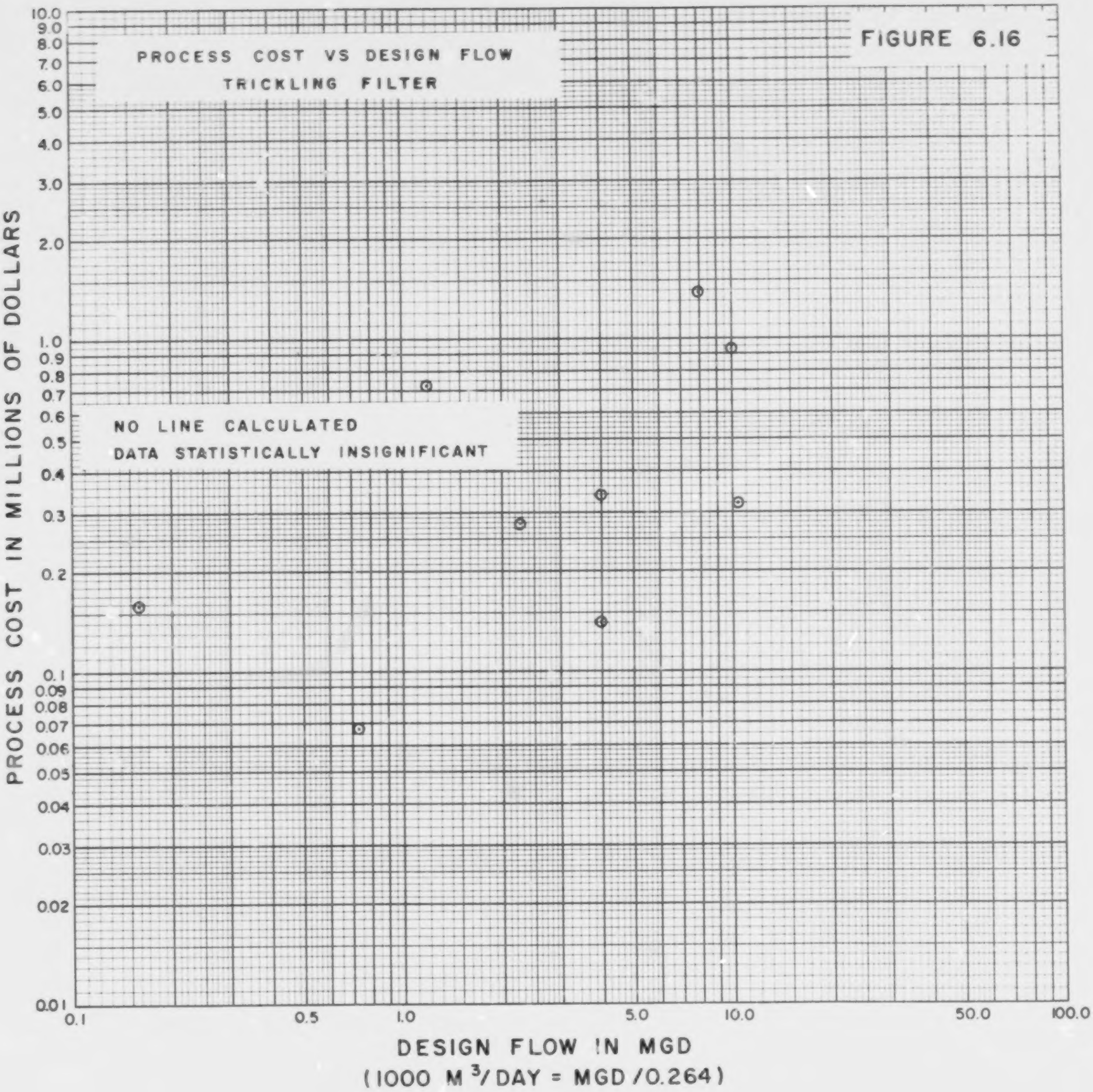


FIGURE 6.15

PROCESS COST VS DESIGN FLOW
PRIMARY SEDIMENTATION

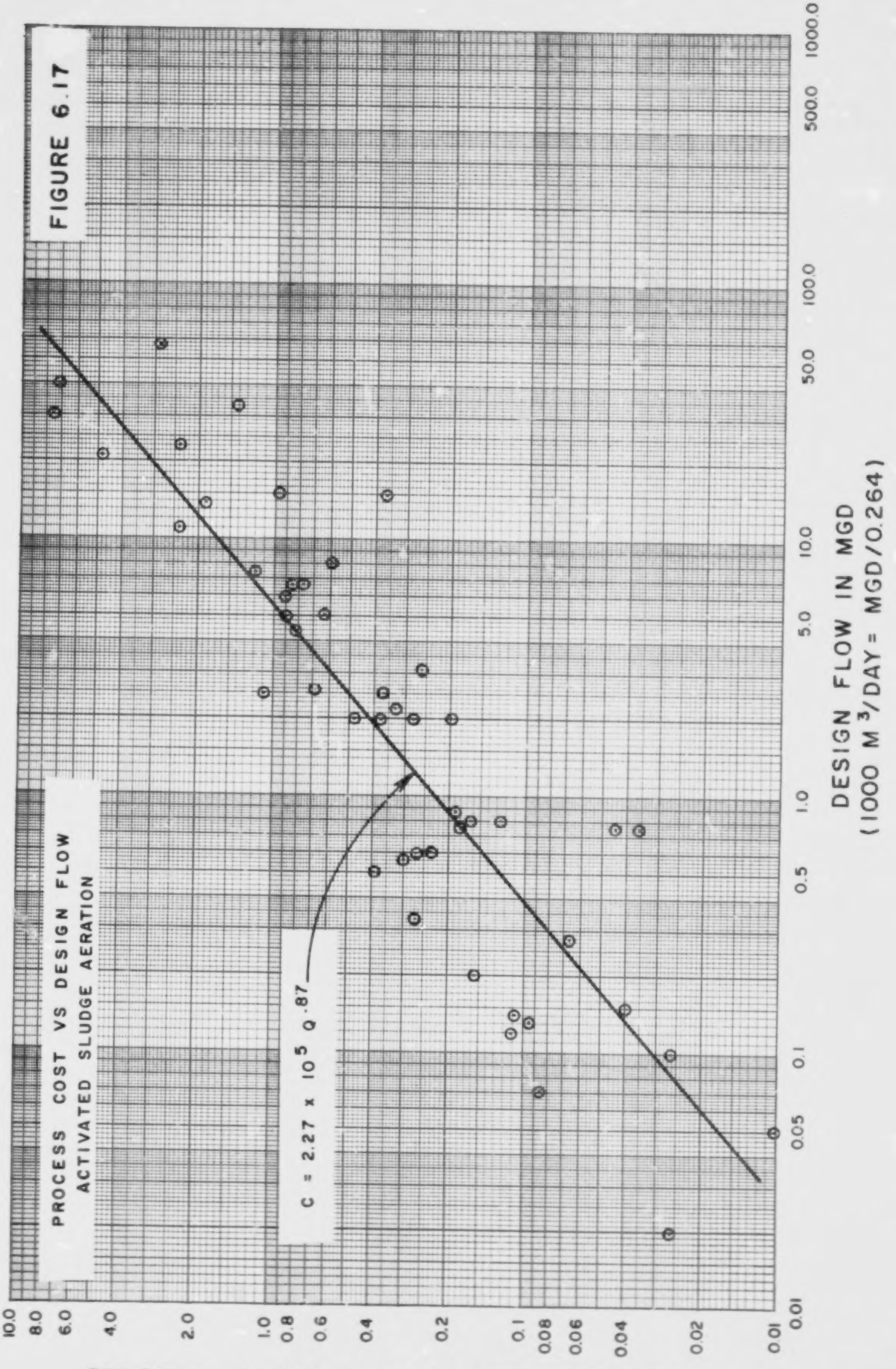
FIGURE 6.16



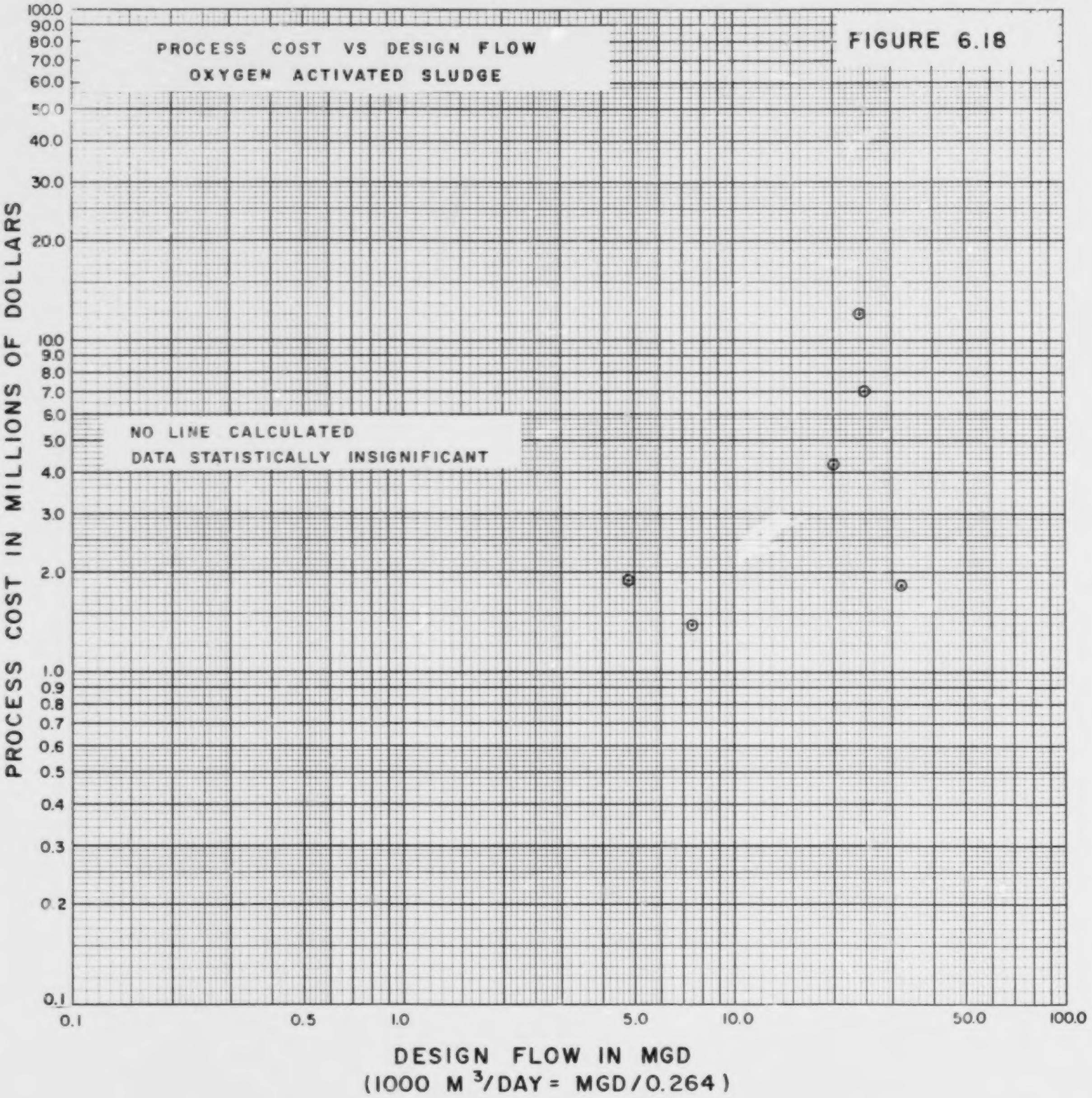
PROCESS COST VS DESIGN FLOW
TRICKLING FILTER

NO LINE CALCULATED
DATA STATISTICALLY INSIGNIFICANT

FIGURE 6.17



PROCESS COST VS DESIGN FLOW
ACTIVATED SLUDGE AERATION


PROCESS COST VS DESIGN FLOW
OXYGEN ACTIVATED SLUDGE
FIGURE 6.18
NO LINE CALCULATED
DATA STATISTICALLY INSIGNIFICANT
PROCESS COST IN MILLIONS OF DOLLARS
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
100
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M 3/DAY = MGD/0.264)

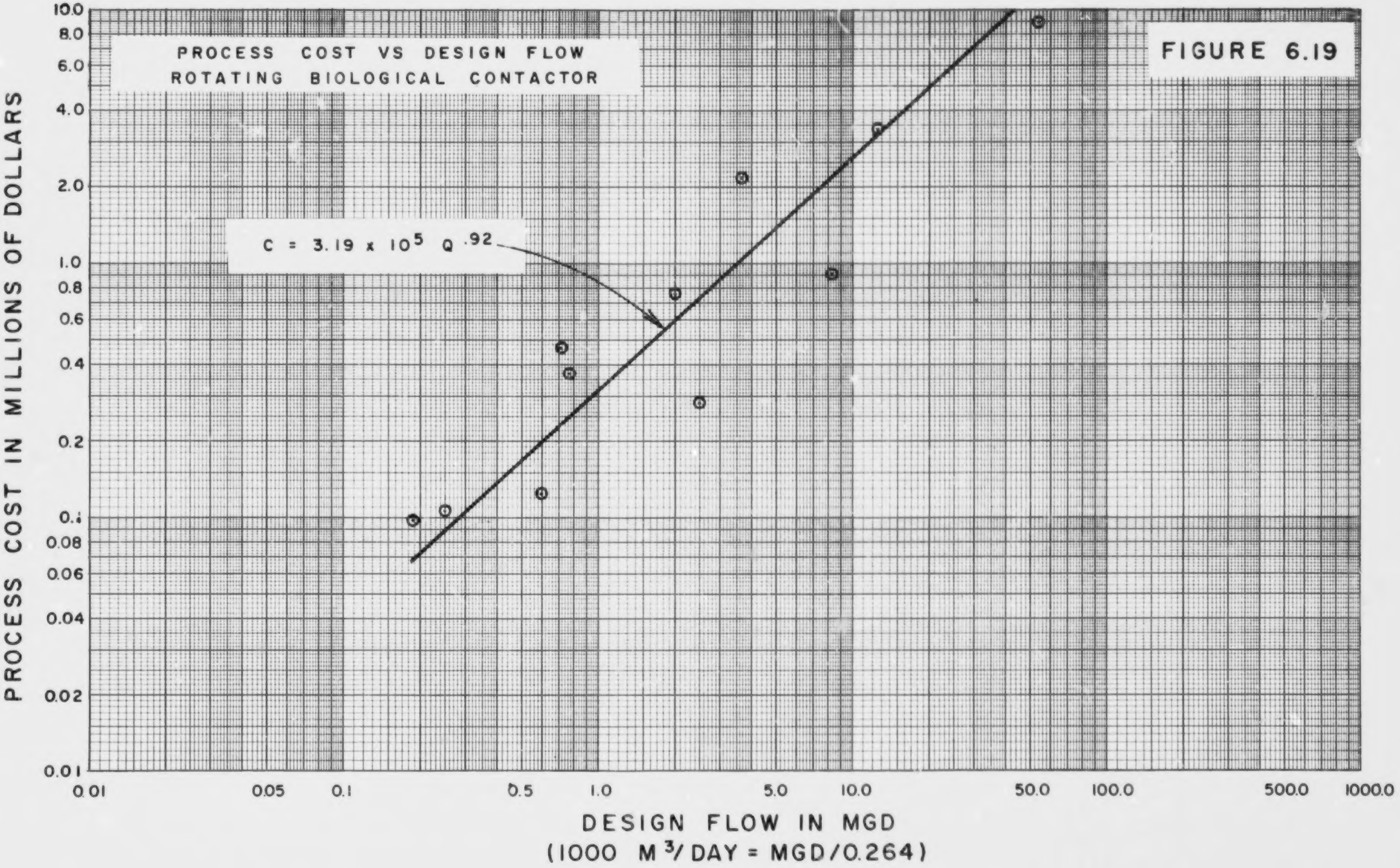


FIGURE 6.19

PROCESS COST VS DESIGN FLOW
ROTATING BIOLOGICAL CONTACTOR

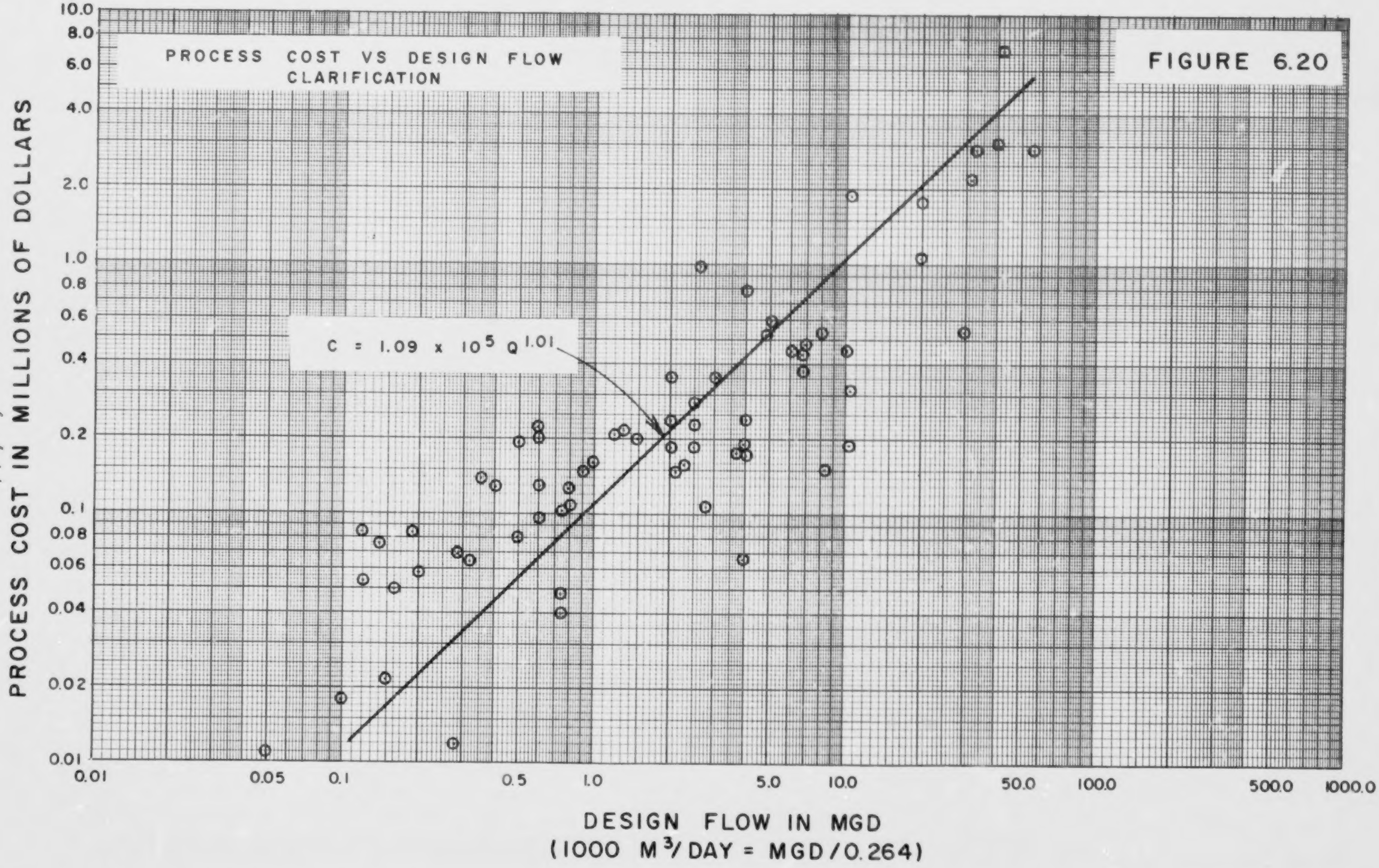


FIGURE 6.20

PROCESS COST VS DESIGN FLOW
CLARIFICATION

6-64

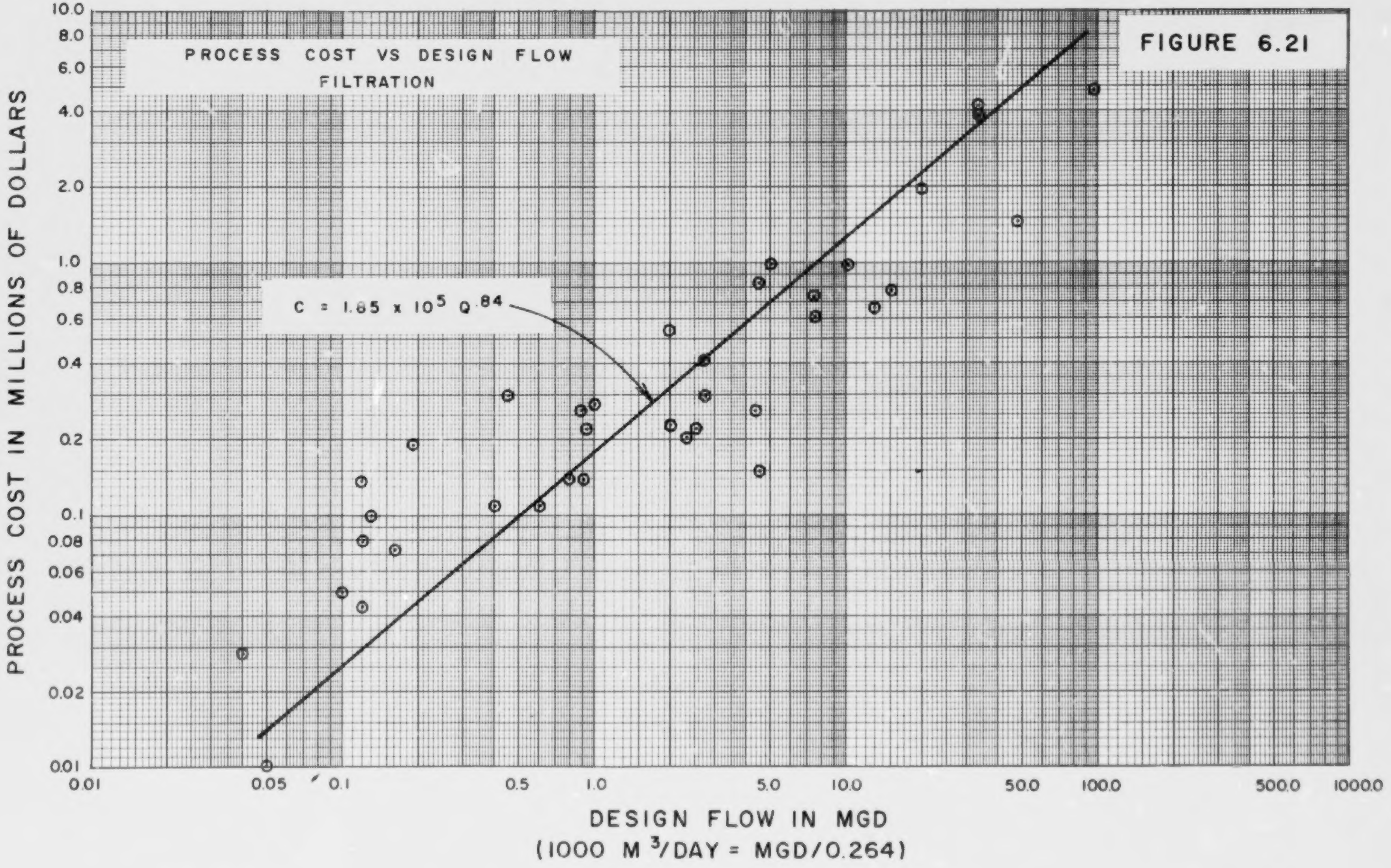


FIGURE 6.21

PROCESS COST VS DESIGN FLOW
FILTRATION
C = 1.85 x 10^5 Q^.84
PROCESS COST IN MILLIONS OF DOLLARS
10.0
8.0
6.0
4.0
2.0
1.0
0.8
0.6
0.4
0.2
0.1
0.08
0.06
0.04
0.02
0.01
0.01
0.05
0.1
0.5
1.0
5.0
10.0
50.0
100.0
500.0
1000.0
DESIGN FLOW IN MGD
(1000 M 3/DAY = MGD/0.264)

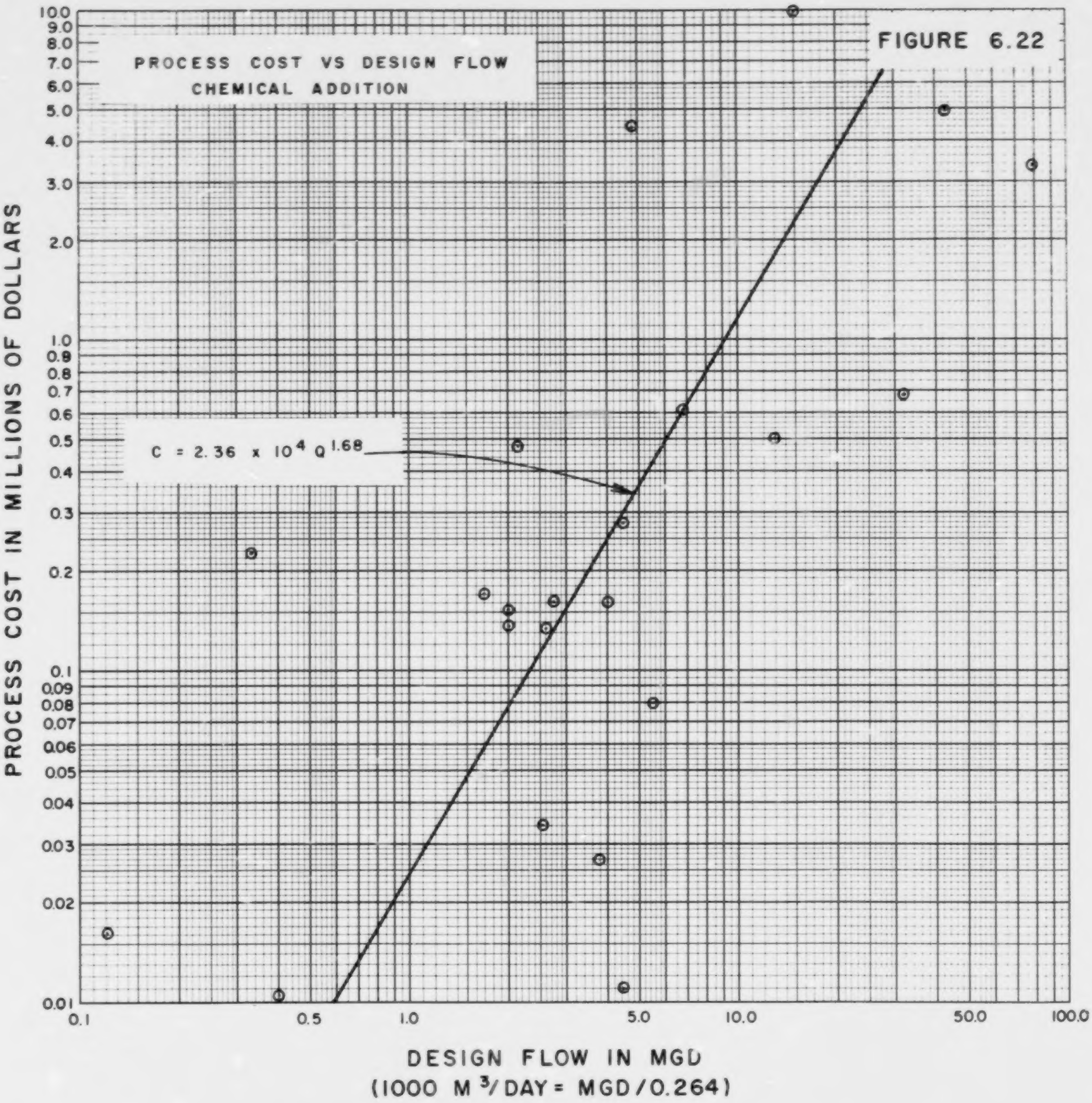


FIGURE 6.22
PROCESS COST VS DESIGN FLOW
CHEMICAL ADDITION
C = 2.36 x 10^4 $Q^{1.68}$
PROCESS COST IN MILLIONS OF DOLLARS
100
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M^3/DAY = MGD/0.264)

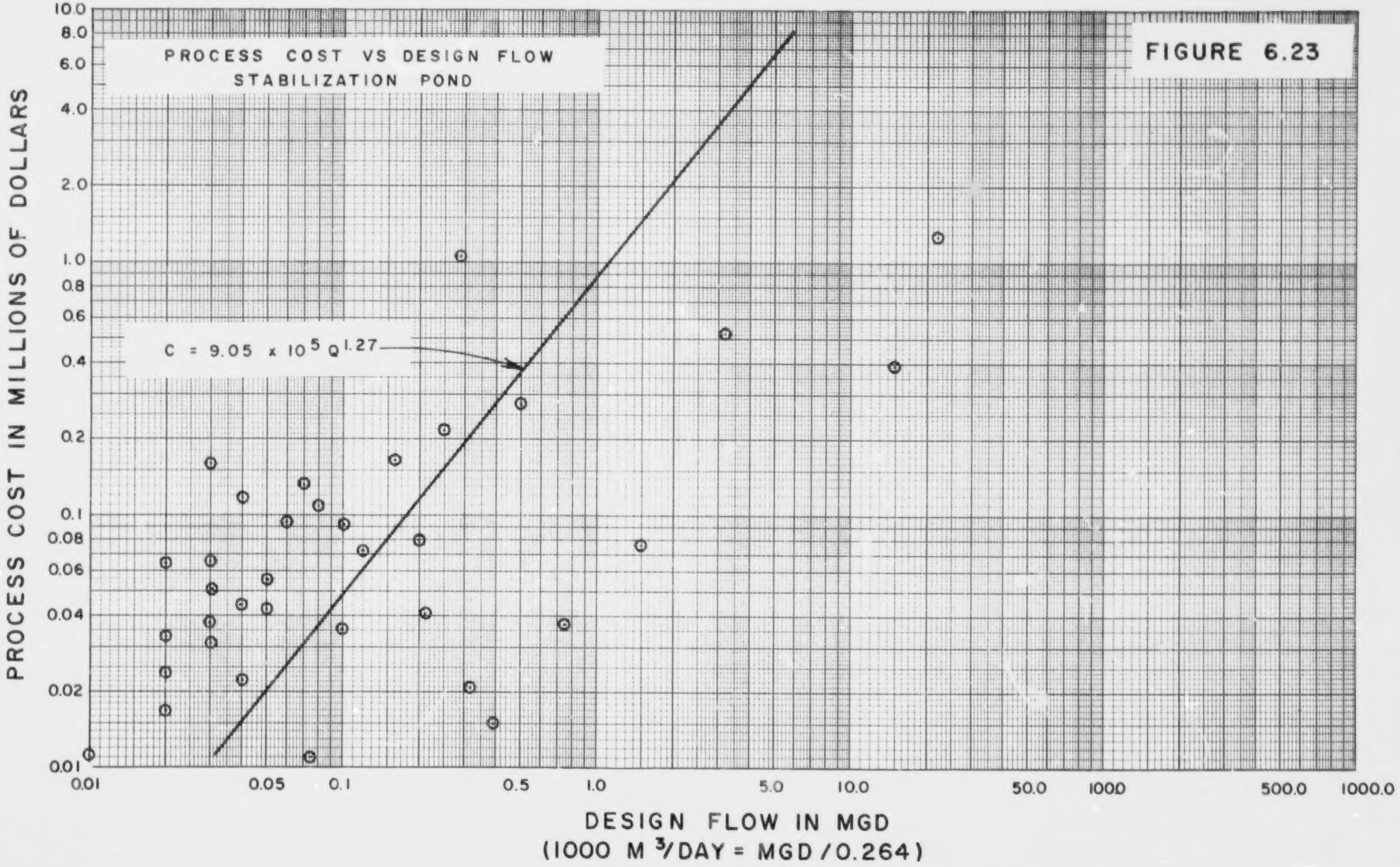


FIGURE 6.23

PROCESS COST VS DESIGN FLOW
STABILIZATION POND

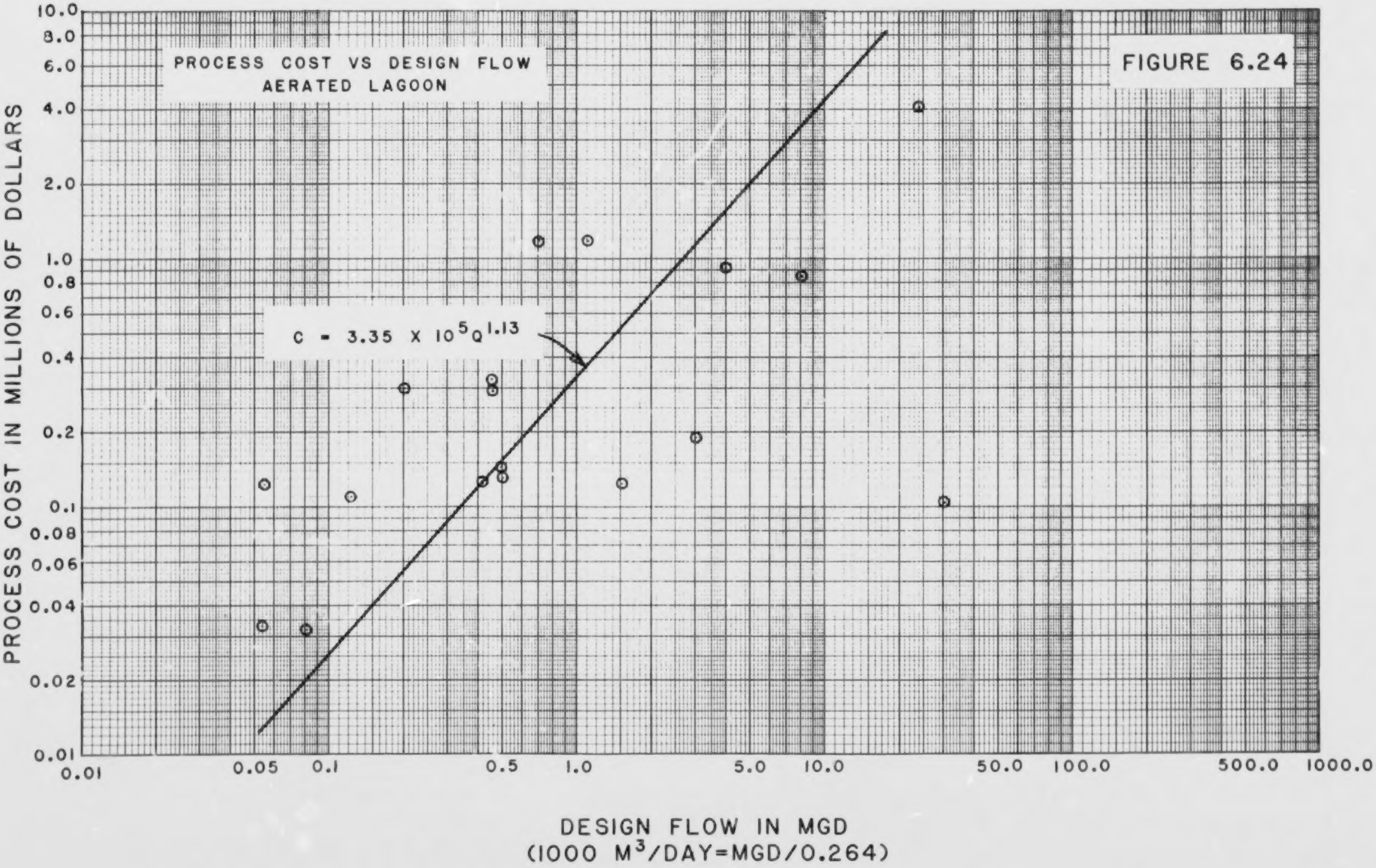
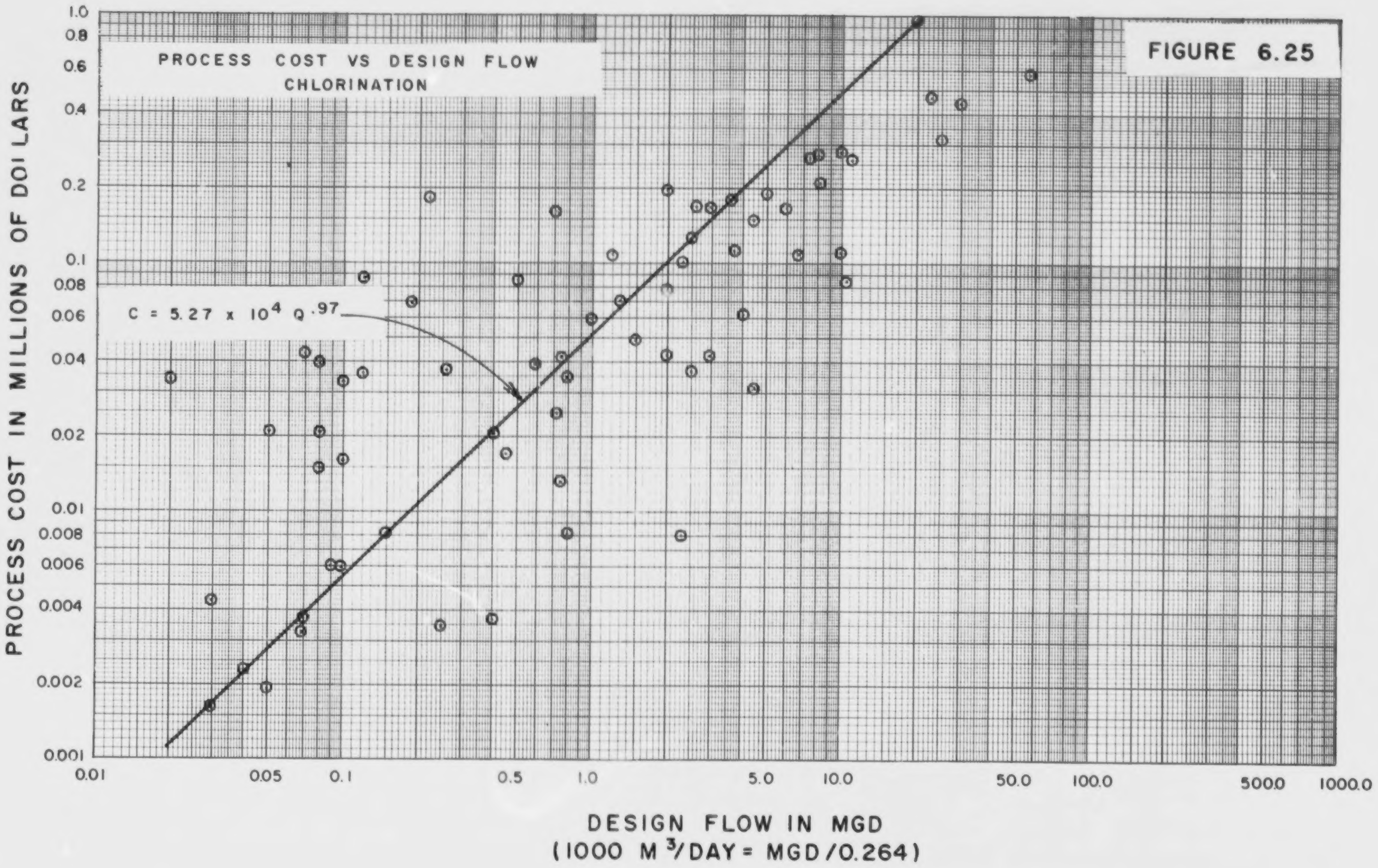


FIGURE 6.24

PROCESS COST VS DESIGN FLOW
AERATED LAGOON



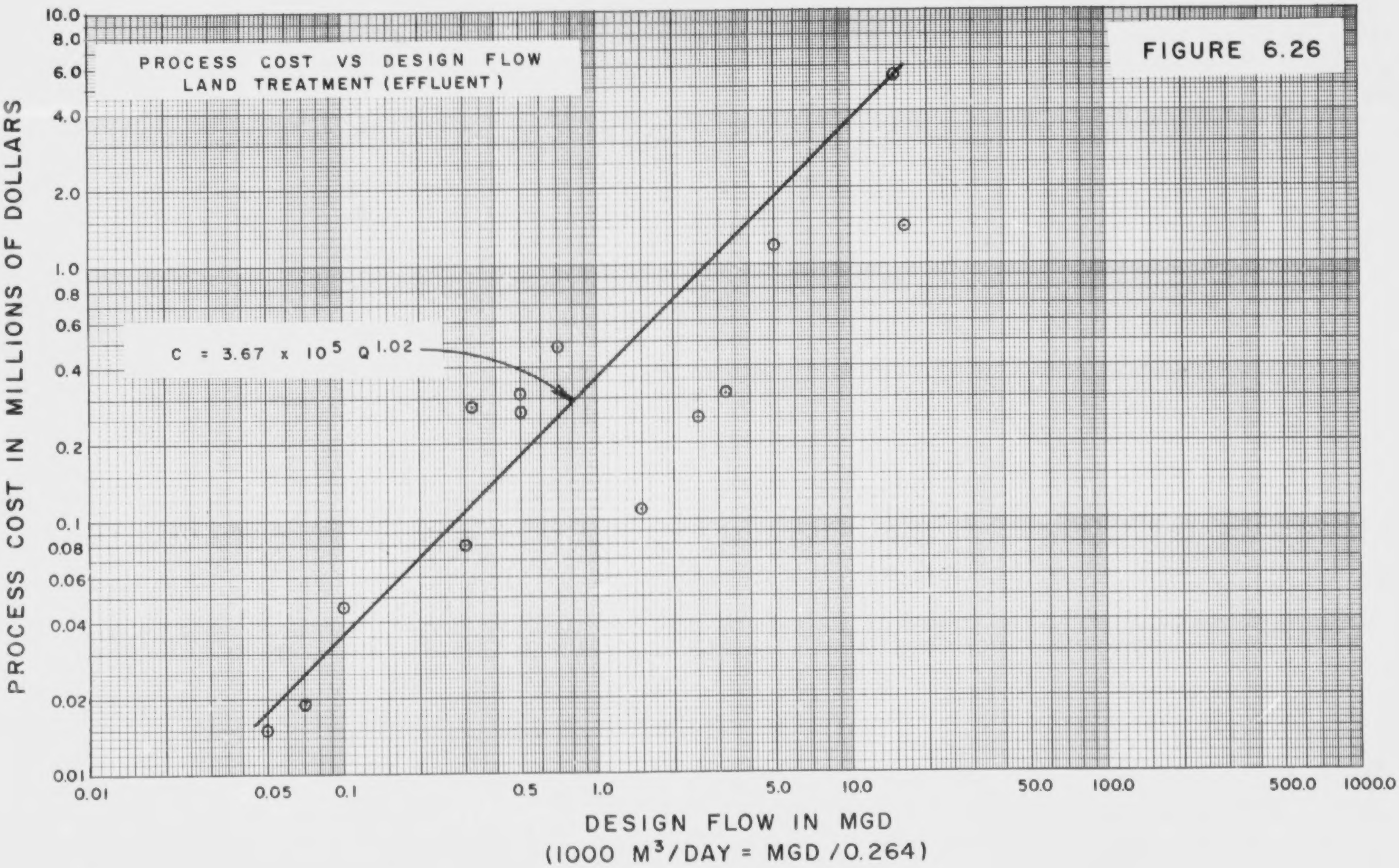


FIGURE 6.26

PROCESS COST VS DESIGN FLOW
LAND TREATMENT (EFFLUENT)

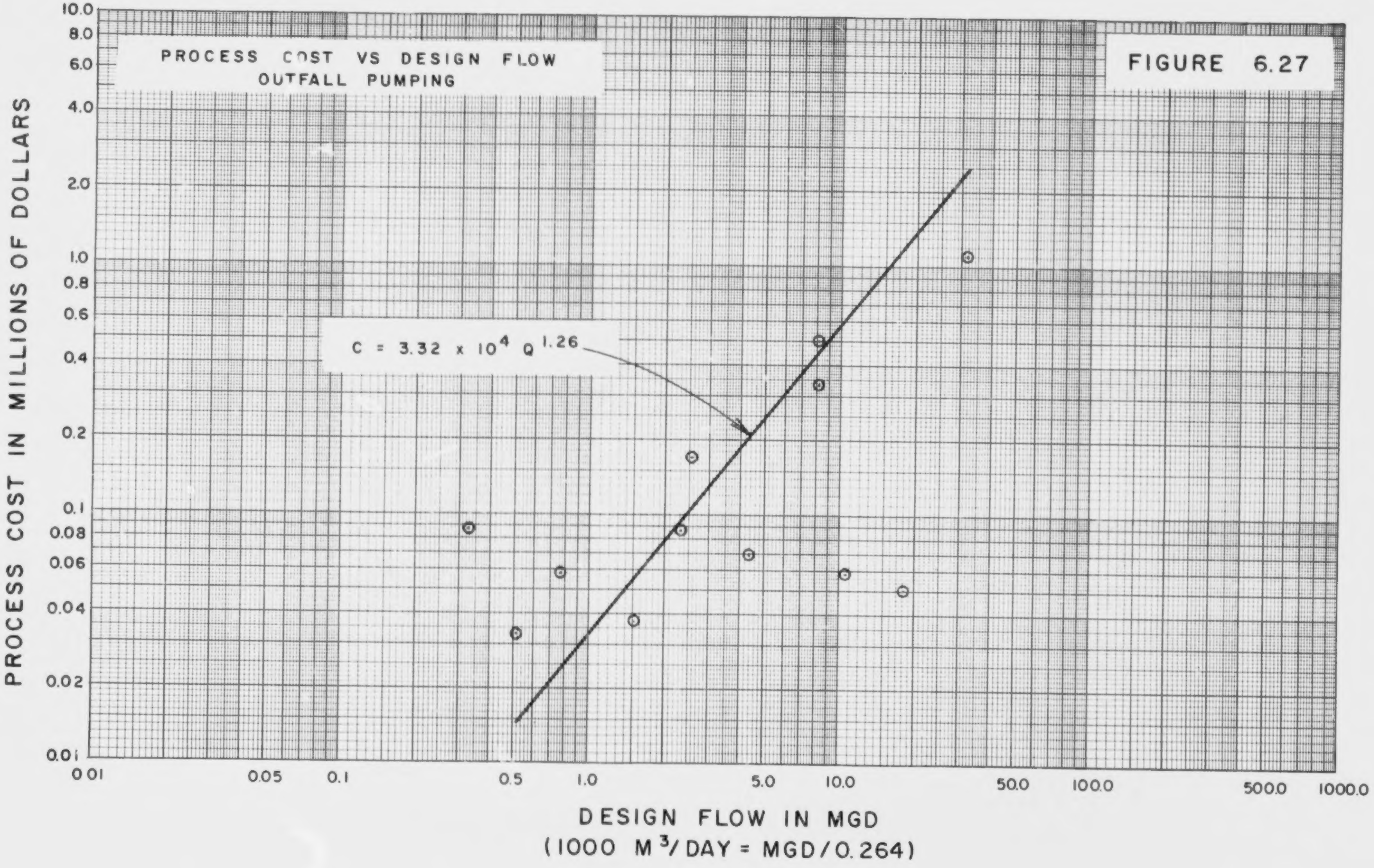
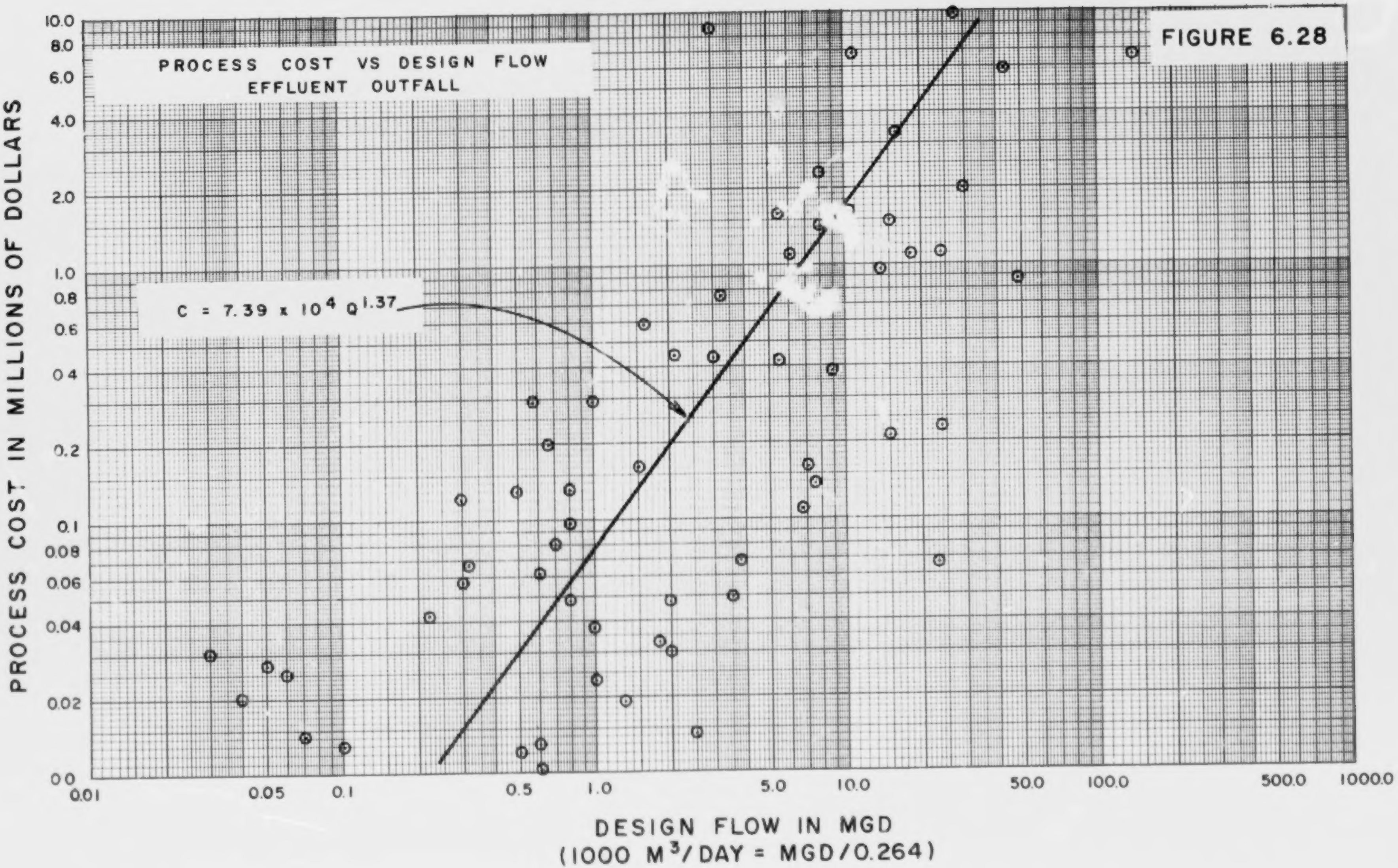


FIGURE 6.27

PROCESS COST VS DESIGN FLOW
OUTFALL PUMPING

FIGURE 6.28



PROCESS COST VS DESIGN FLOW
EFFLUENT OUTFALL

FIGURE 6.29

PROCESS COST VS DESIGN FLOW
OUTFALL DIFFUSION

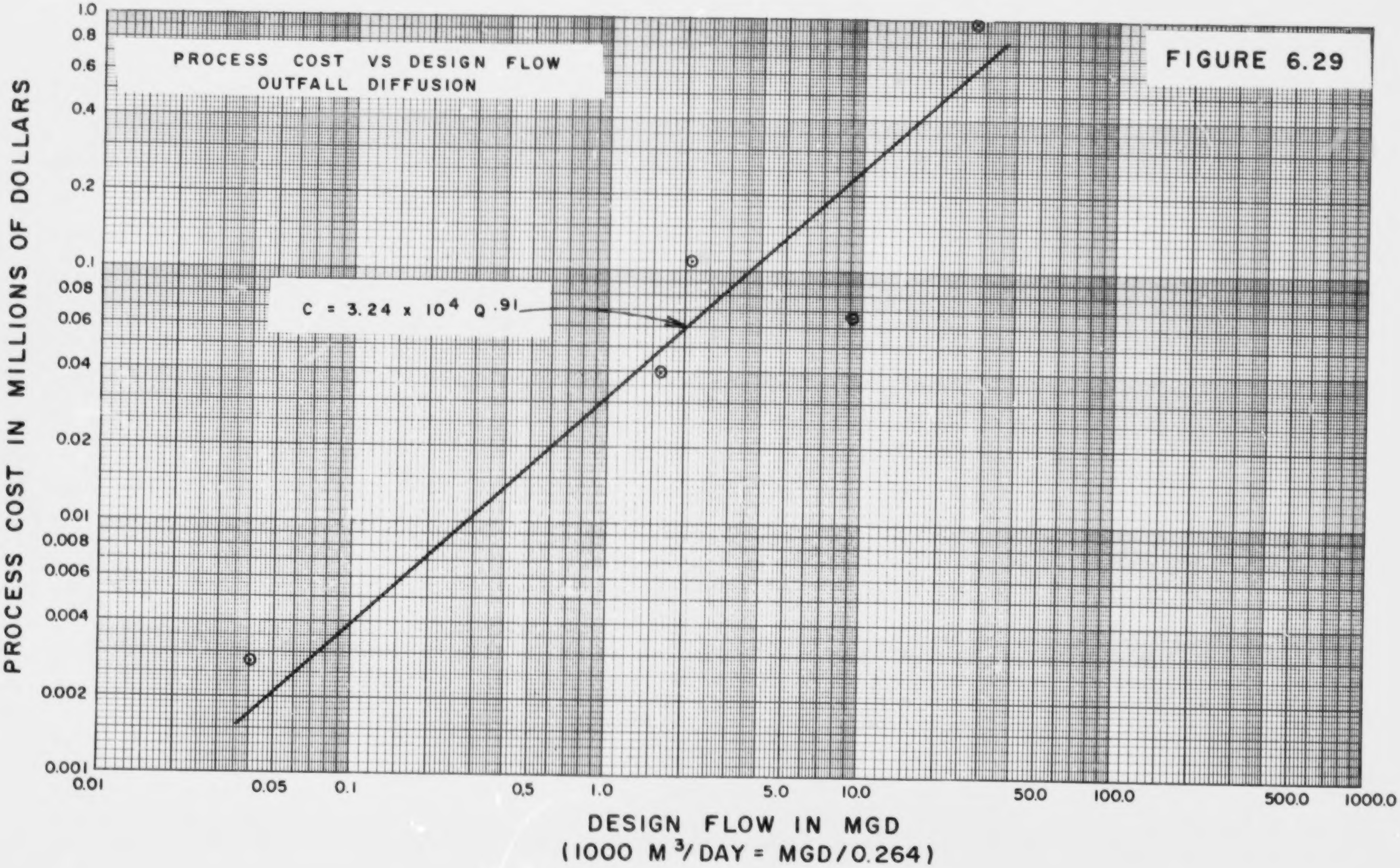
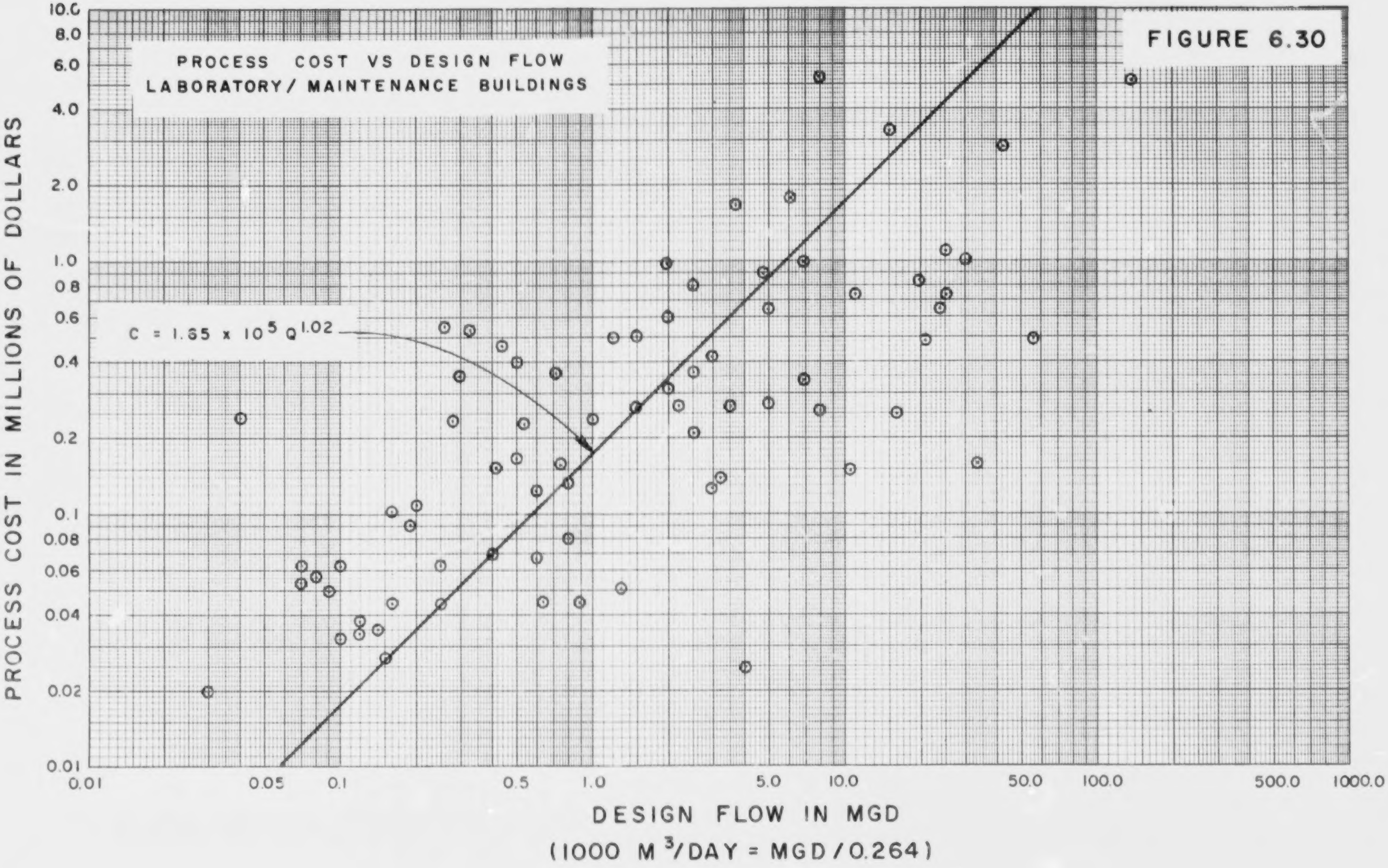


FIGURE 6.30



PROCESS COST VS DESIGN FLOW
LABORATORY/ MAINTENANCE BUILDINGS

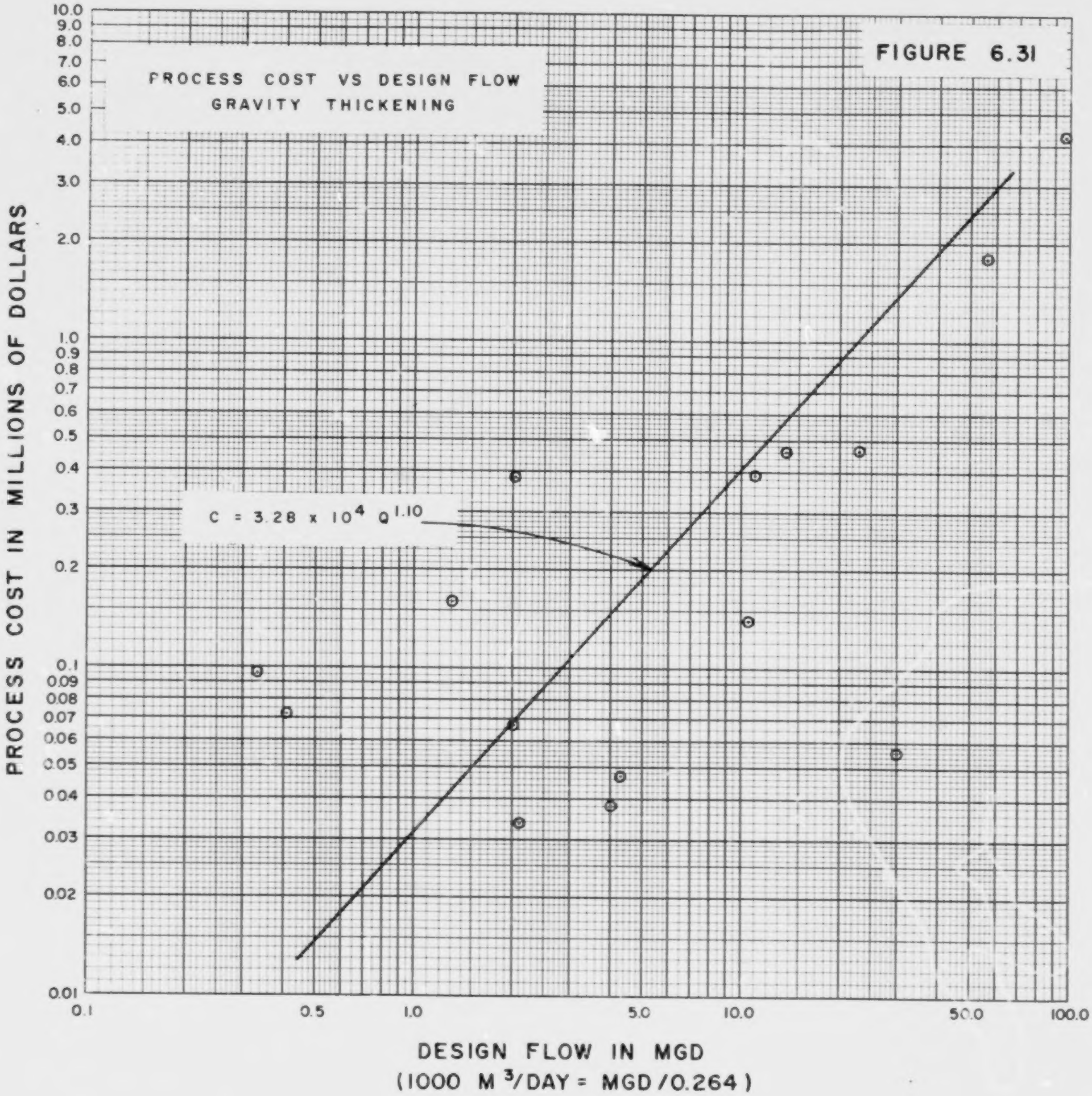


FIGURE 6.31
PROCESS COST VS DESIGN FLOW
GRAVITY THICKENING
C = 3.28 x 10^4 Q^1.10
PROCESS COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

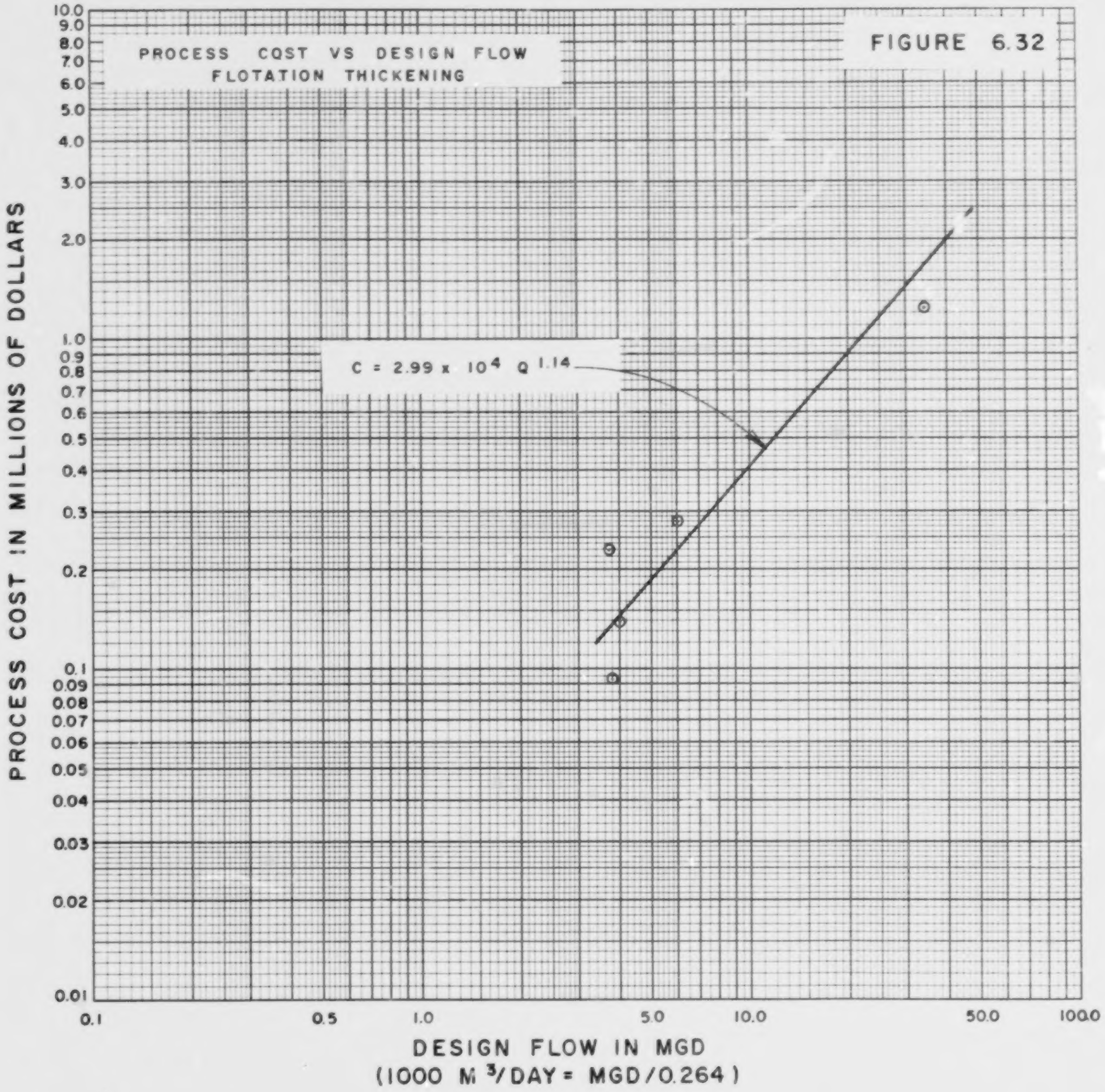


FIGURE 6.32

PROCESS COST VS DESIGN FLOW
FLOTATION THICKENING

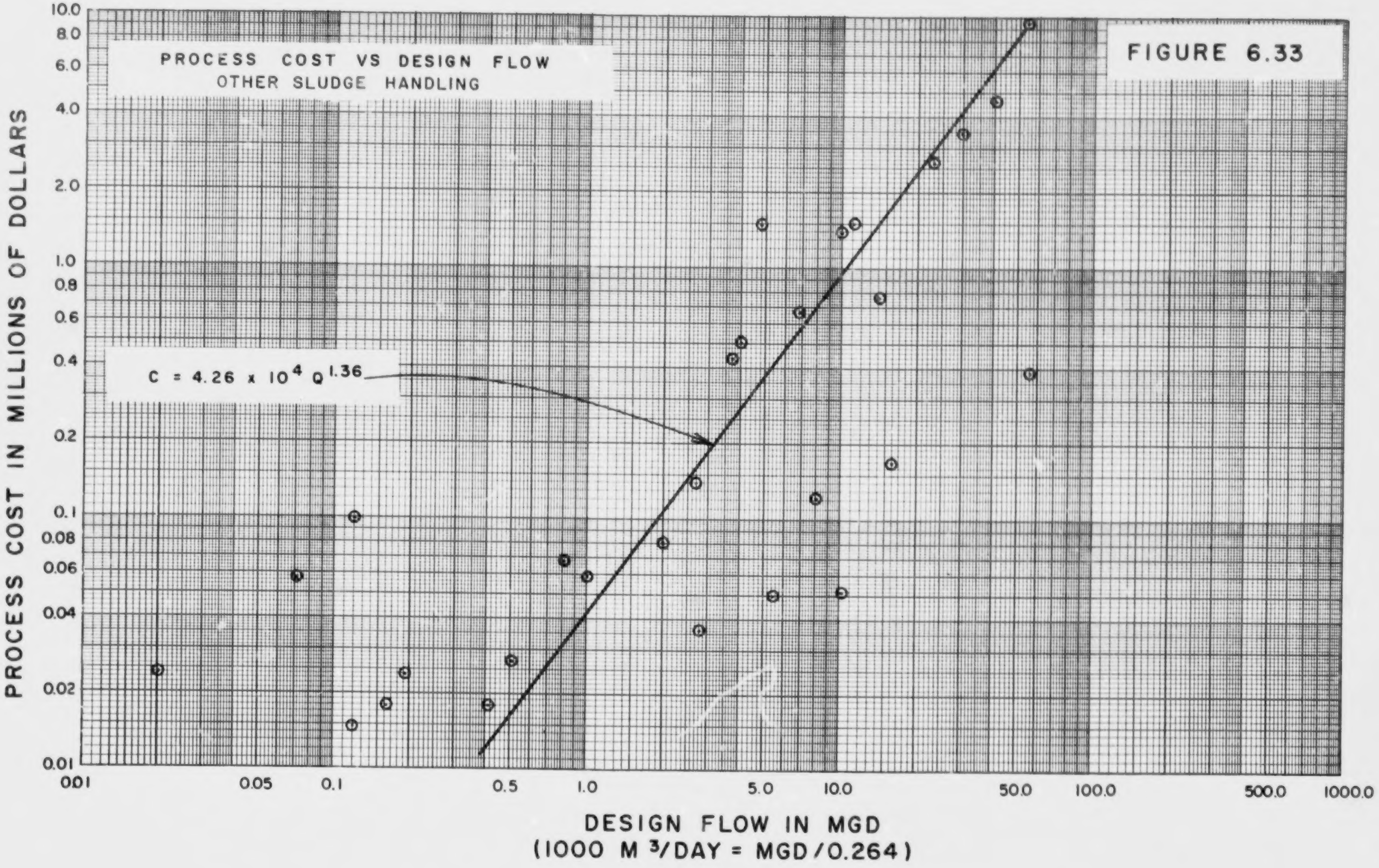
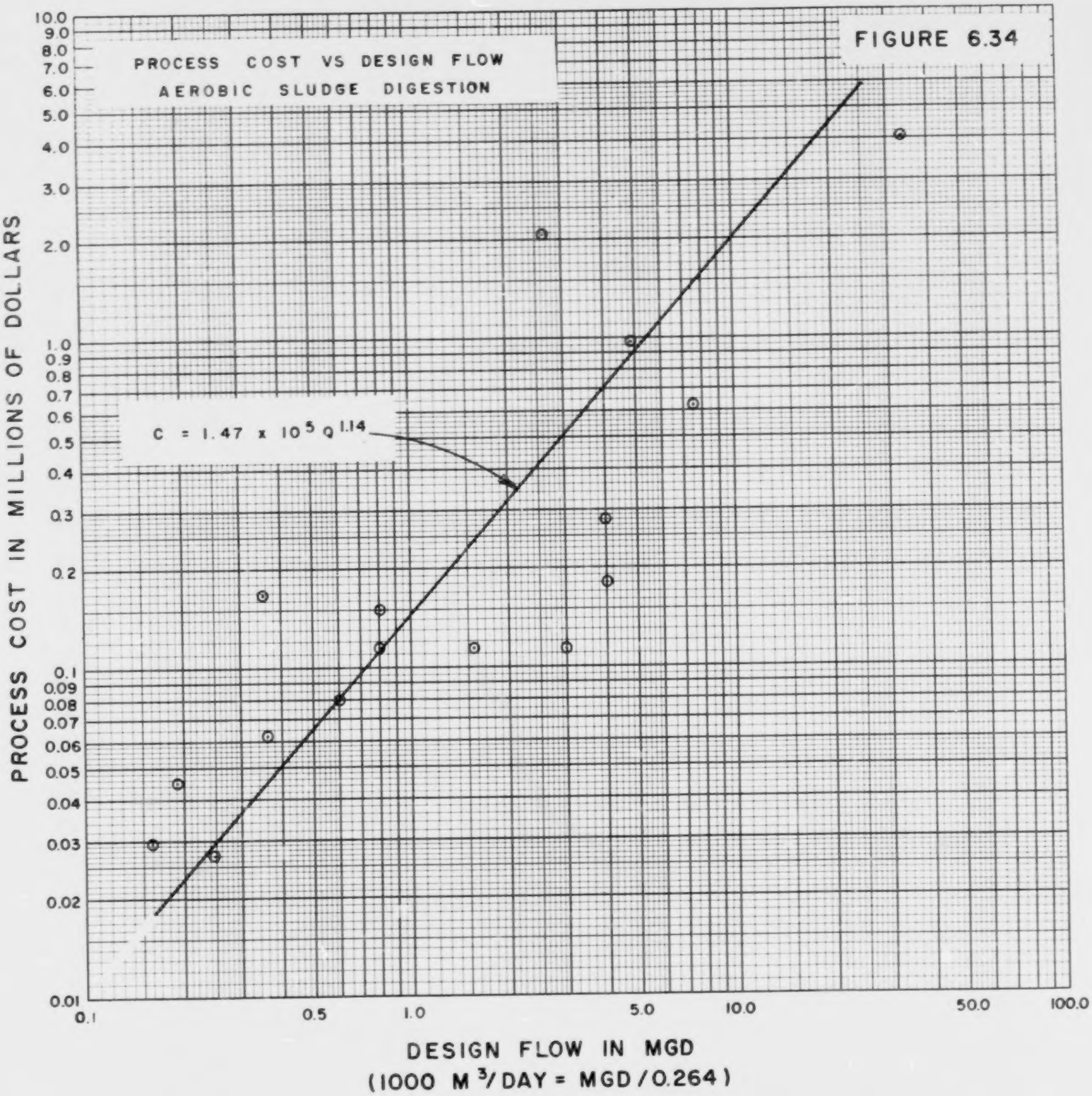
PROCESS COST VS DESIGN FLOW
OTHER SLUDGE HANDLING
C = 4.26 x 10^4 Q^1.36
PROCESS COST IN MILLIONS OF DOLLARS
10.0
8.0
6.0
4.0
2.0
1.0
0.8
0.6
0.4
0.2
0.1
0.08
0.06
0.04
0.02
0.01
0.01
0.05
0.1
0.5
1.0
5.0
10.0
50.0
100.0
500.0
1000.0
DESIGN FLOW IN MGD
(1000 M 3/DAY = MGD/0.264)

FIGURE 6.33

FIGURE 6.34

PROCESS COST VS DESIGN FLOW
AEROBIC SLUDGE DIGESTION



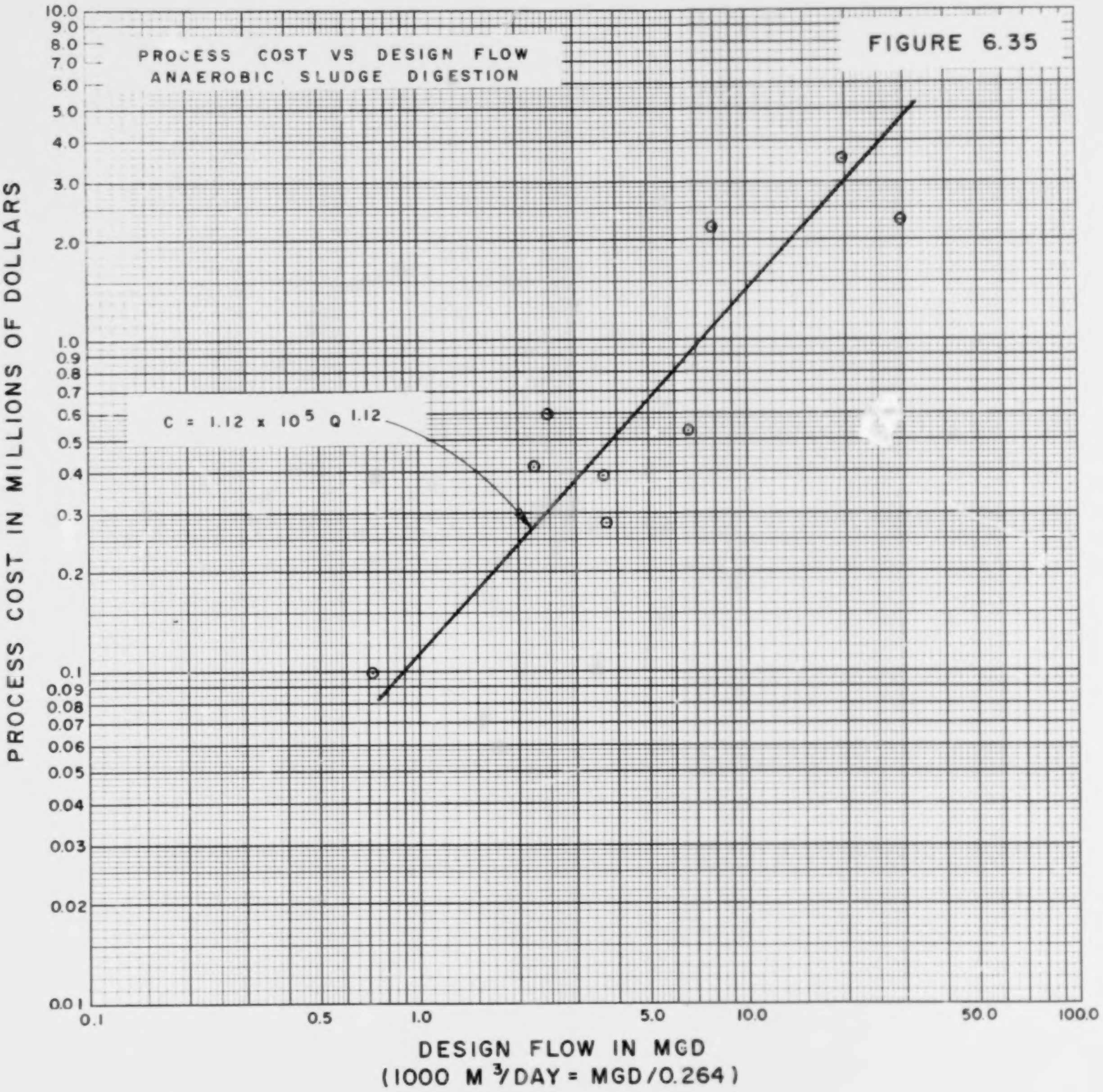


FIGURE 6.35

PROCESS COST VS DESIGN FLOW
ANAEROBIC SLUDGE DIGESTION

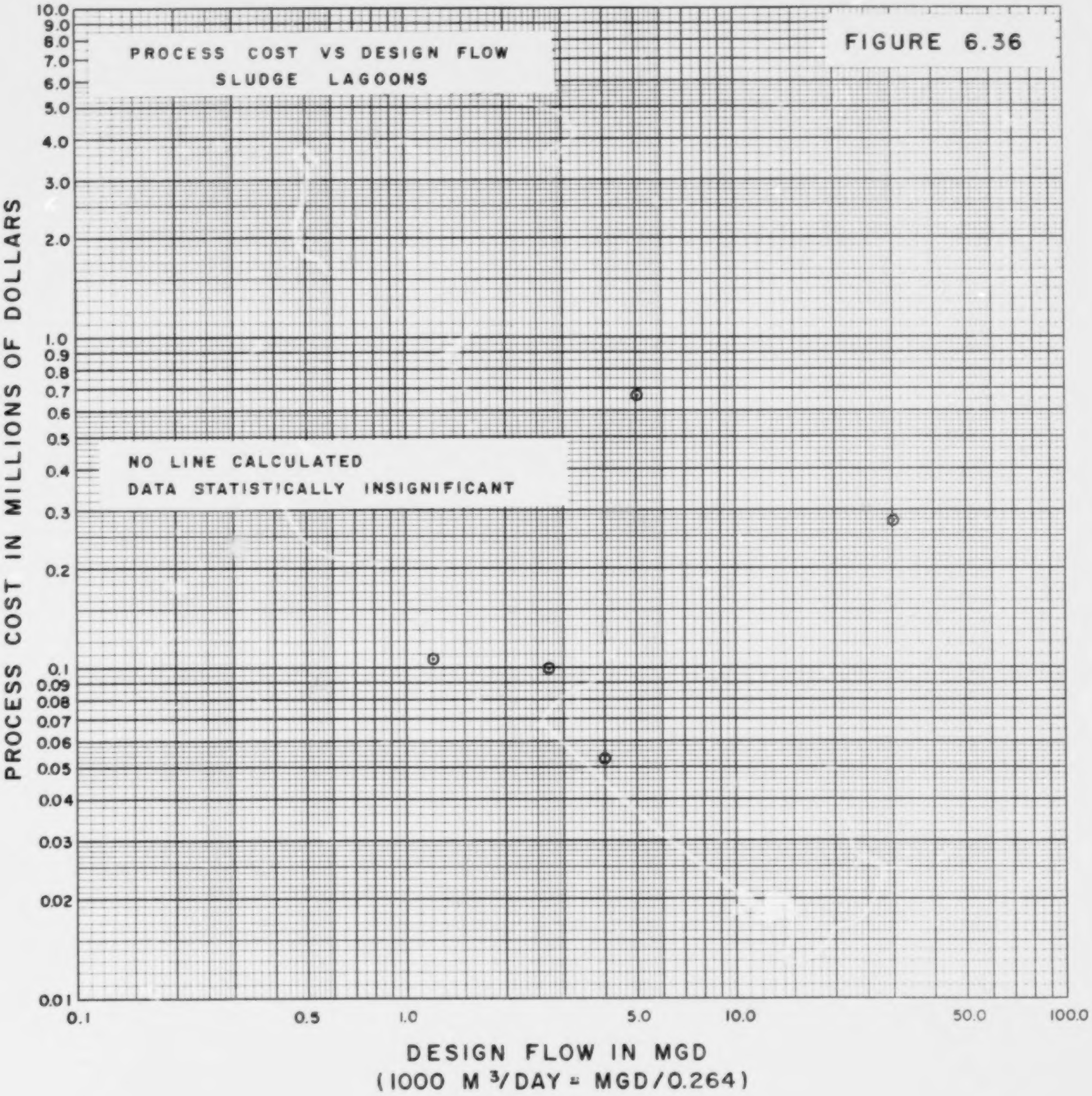
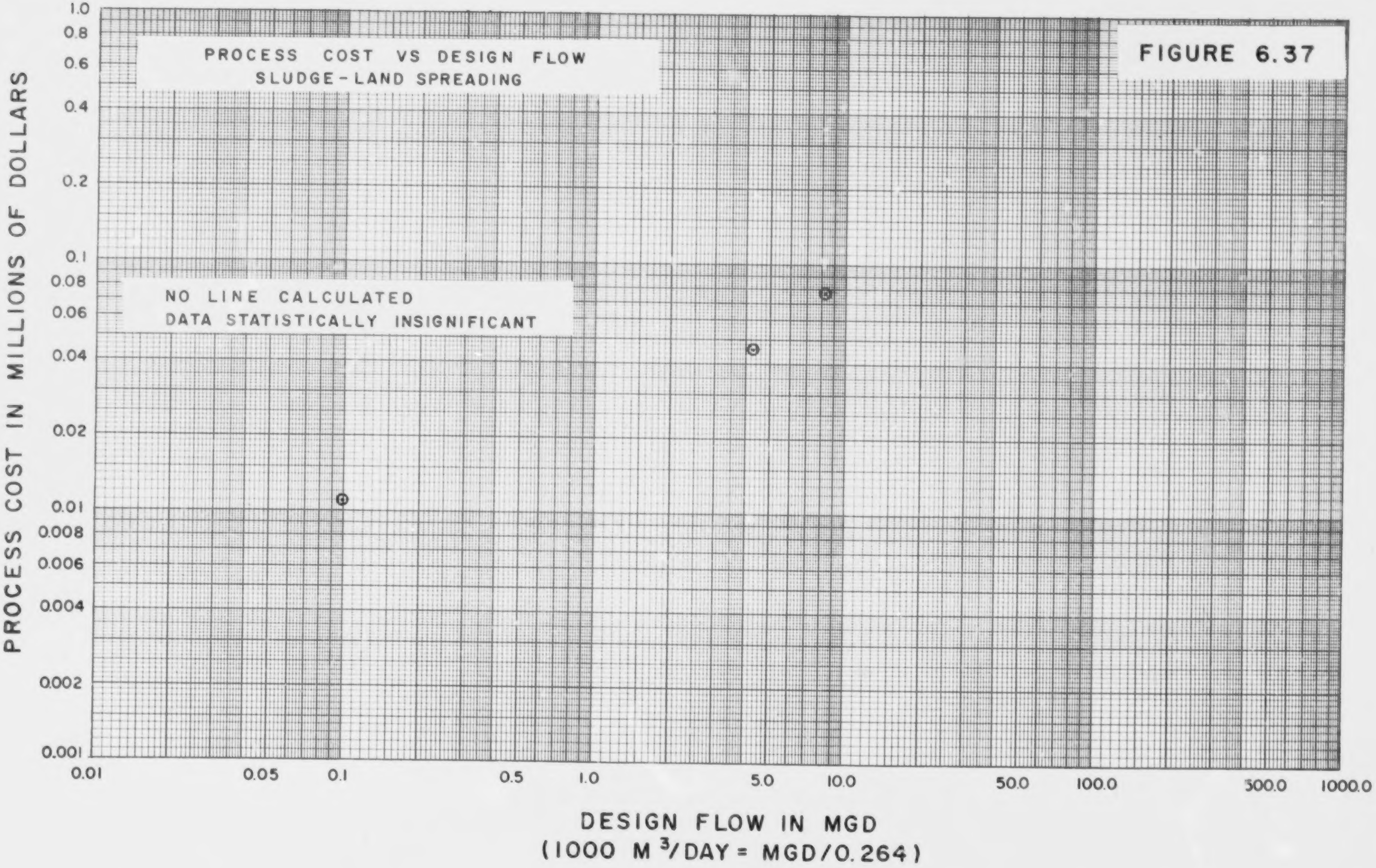


FIGURE 6.36
PROCESS COST VS DESIGN FLOW
SLUDGE LAGOONS
NO LINE CALCULATED
DATA STATISTICALLY INSIGNIFICANT
PROCESS COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

FIGURE 6.37



PROCESS COST VS DESIGN FLOW
SLUDGE-LAND SPREADING

NO LINE CALCULATED
DATA STATISTICALLY INSIGNIFICANT

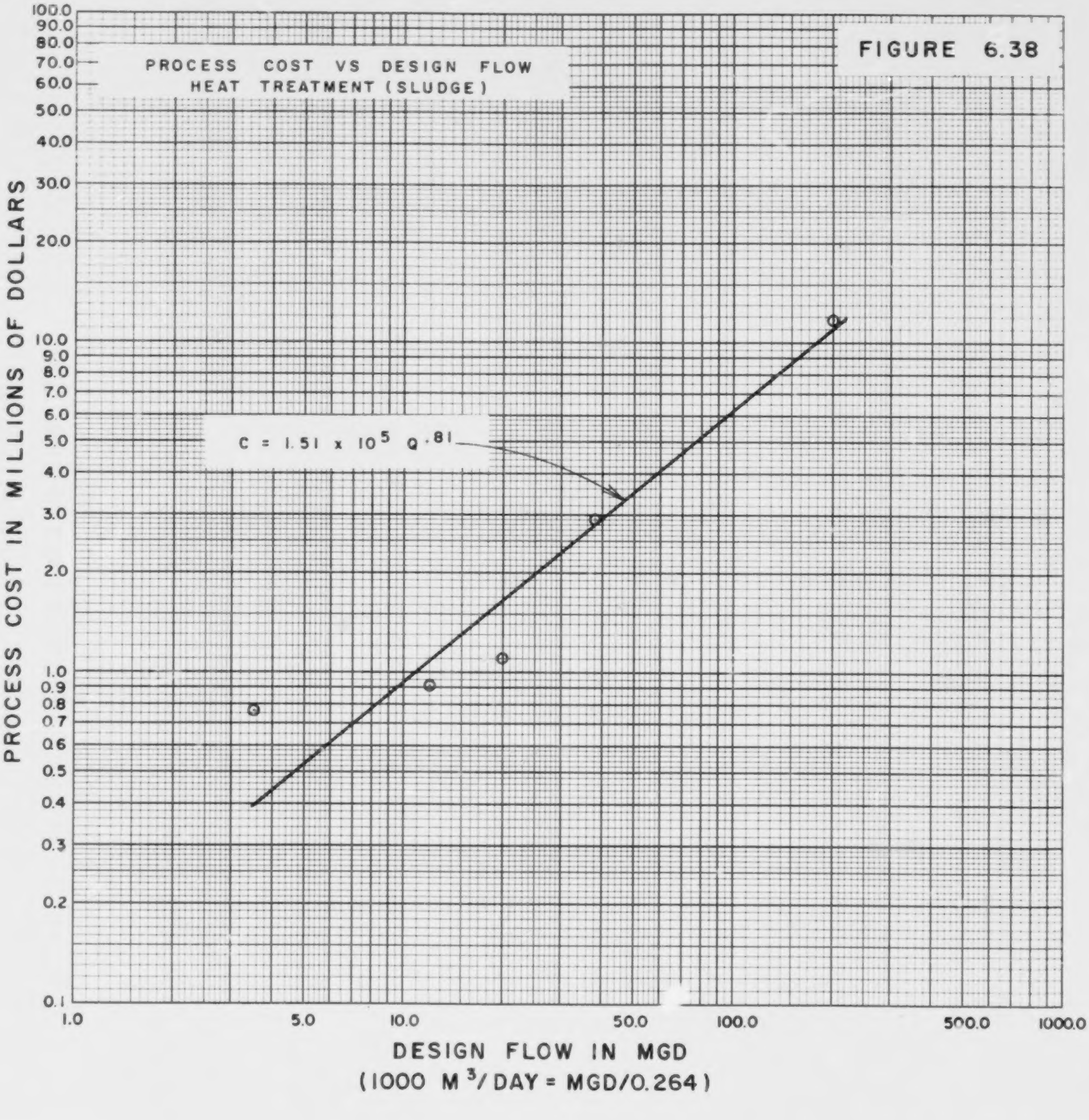


FIGURE 6.38

PROCESS COST VS DESIGN FLOW
HEAT TREATMENT (SLUDGE)

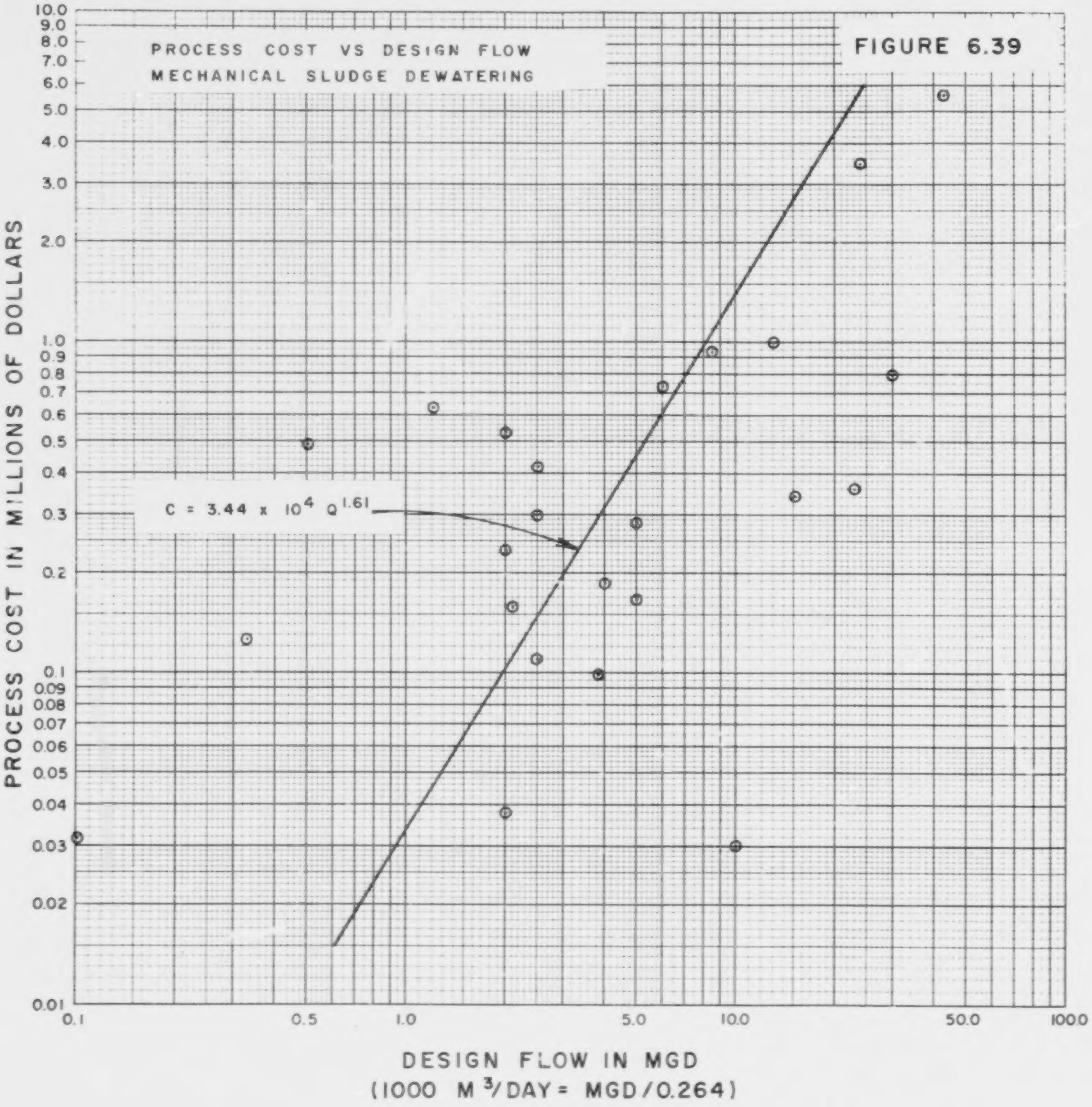


FIGURE 6.39

PROCESS COST VS DESIGN FLOW
MECHANICAL SLUDGE DEWATERING

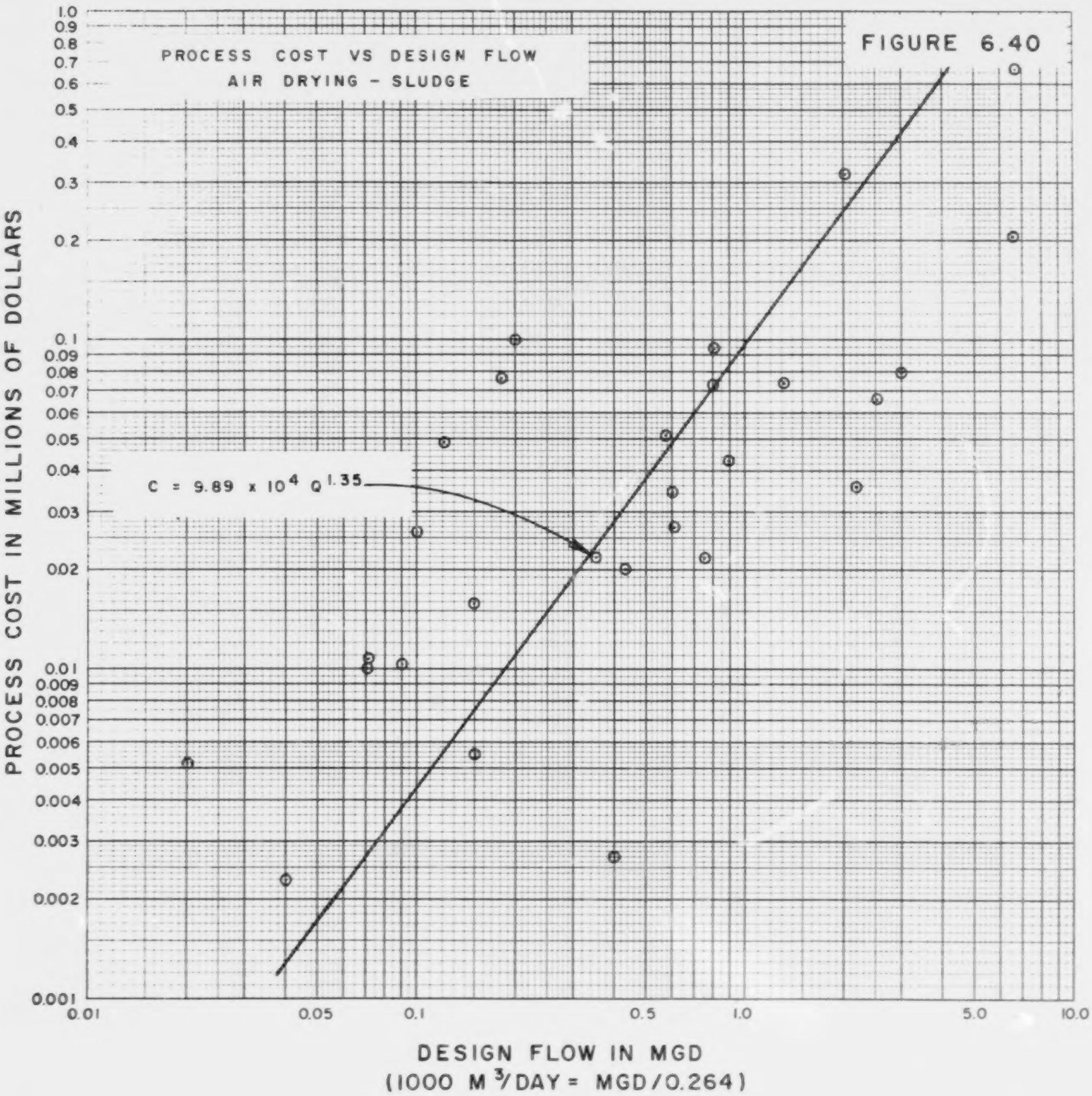


FIGURE 6.40

PROCESS COST VS DESIGN FLOW
AIR DRYING - SLUDGE

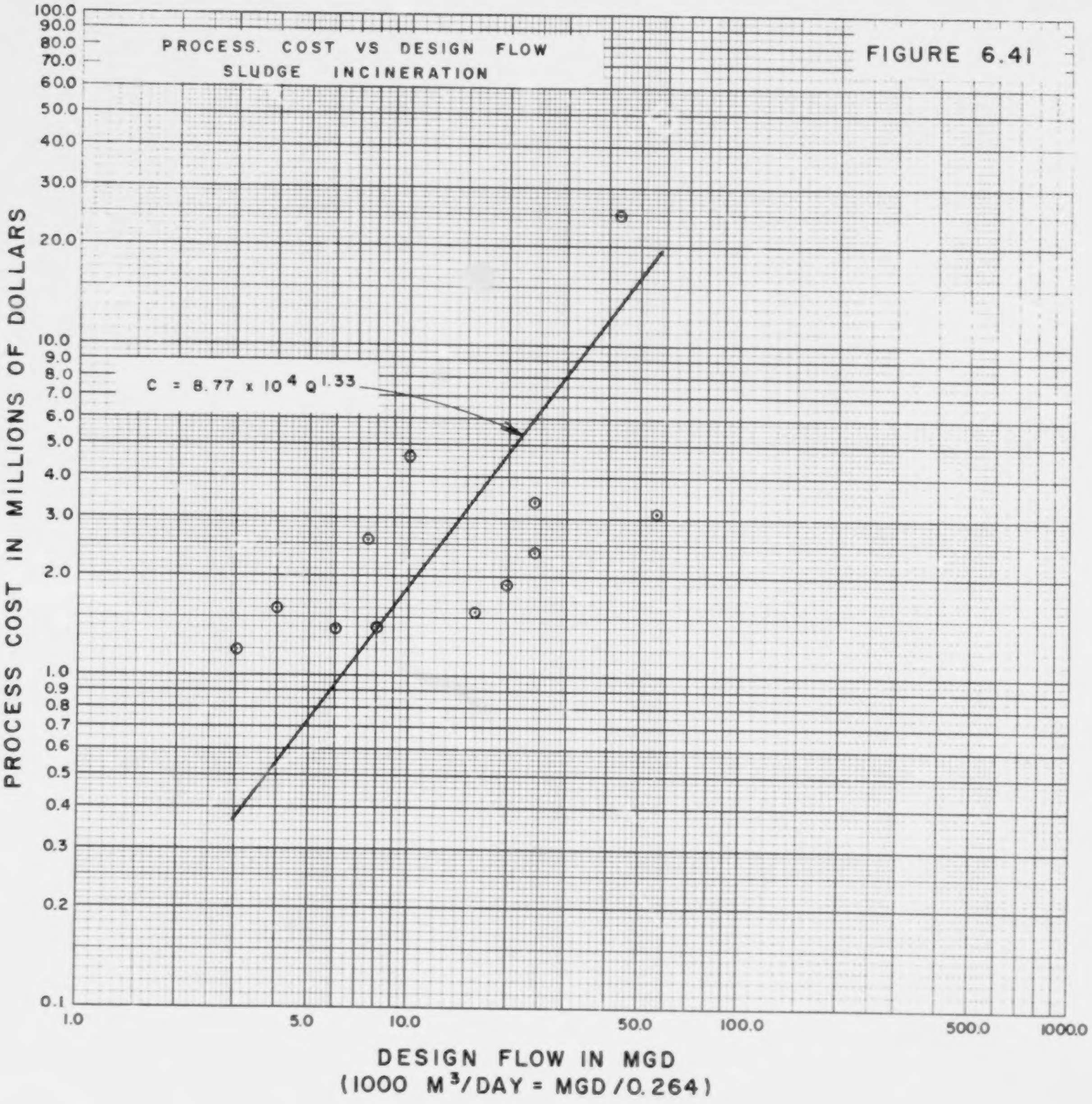


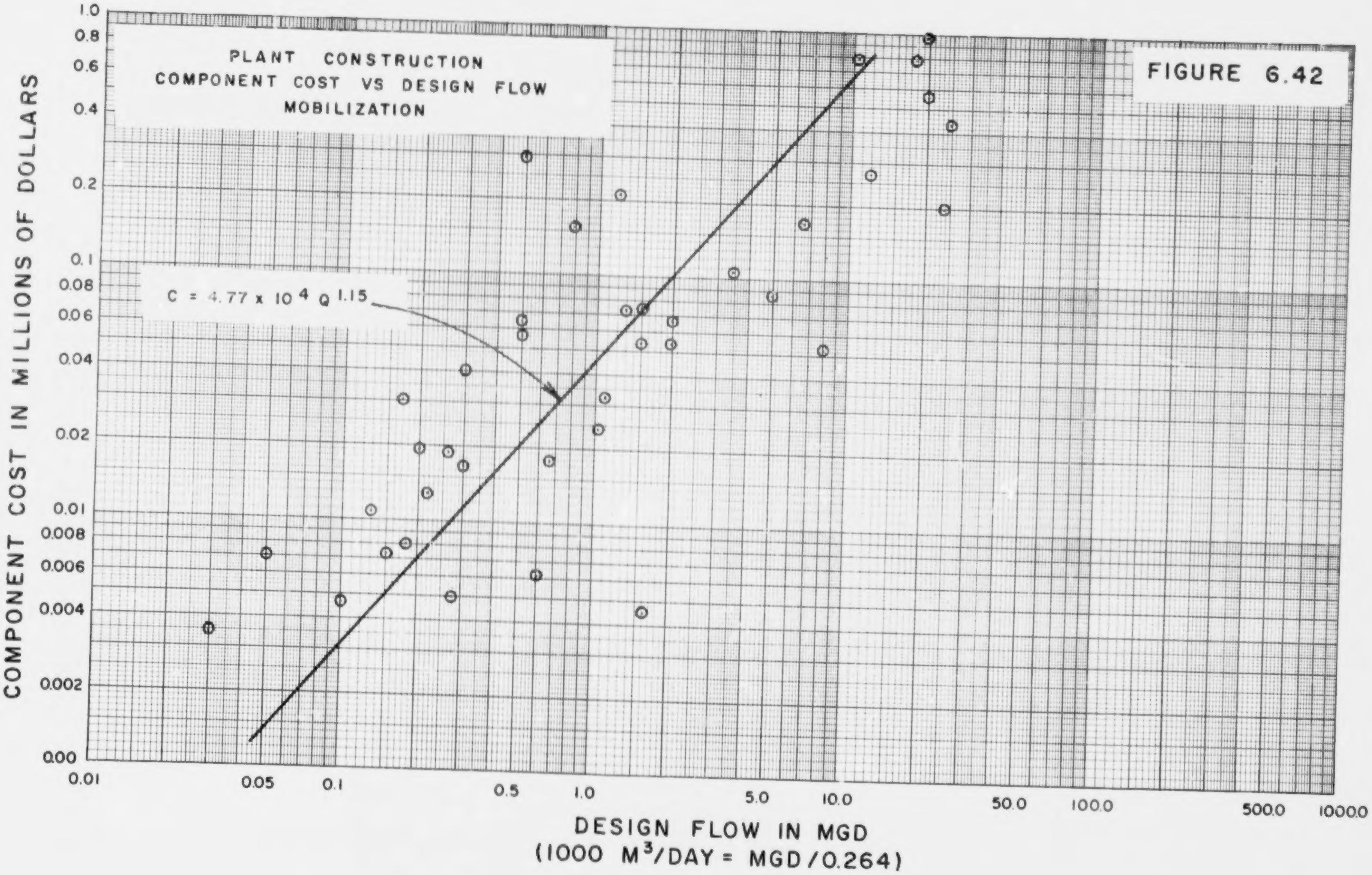
FIGURE 6.41

PROCESS COST VS DESIGN FLOW
SLUDGE INCINERATION

SECOND ORDER COST CURVES

(PLANT CONSTRUCTION COMPONENT COSTS)

FIGURE 6.42


PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
MOBILIZATION
C = 4.77 x 10 4 Q 1.15
COMPONENT COST IN MILLIONS OF DOLLARS
1.0
0.8
0.6
0.4
0.2
0.1
0.08
0.06
0.04
0.02
0.01
0.008
0.006
0.004
0.002
0.00
0.01
0.05
0.1
0.5
1.0
5.0
10.0
50.0
100.0
500.0
1000.0
DESIGN FLOW IN MGD
(1000 M3/DAY = MGD/0.264)

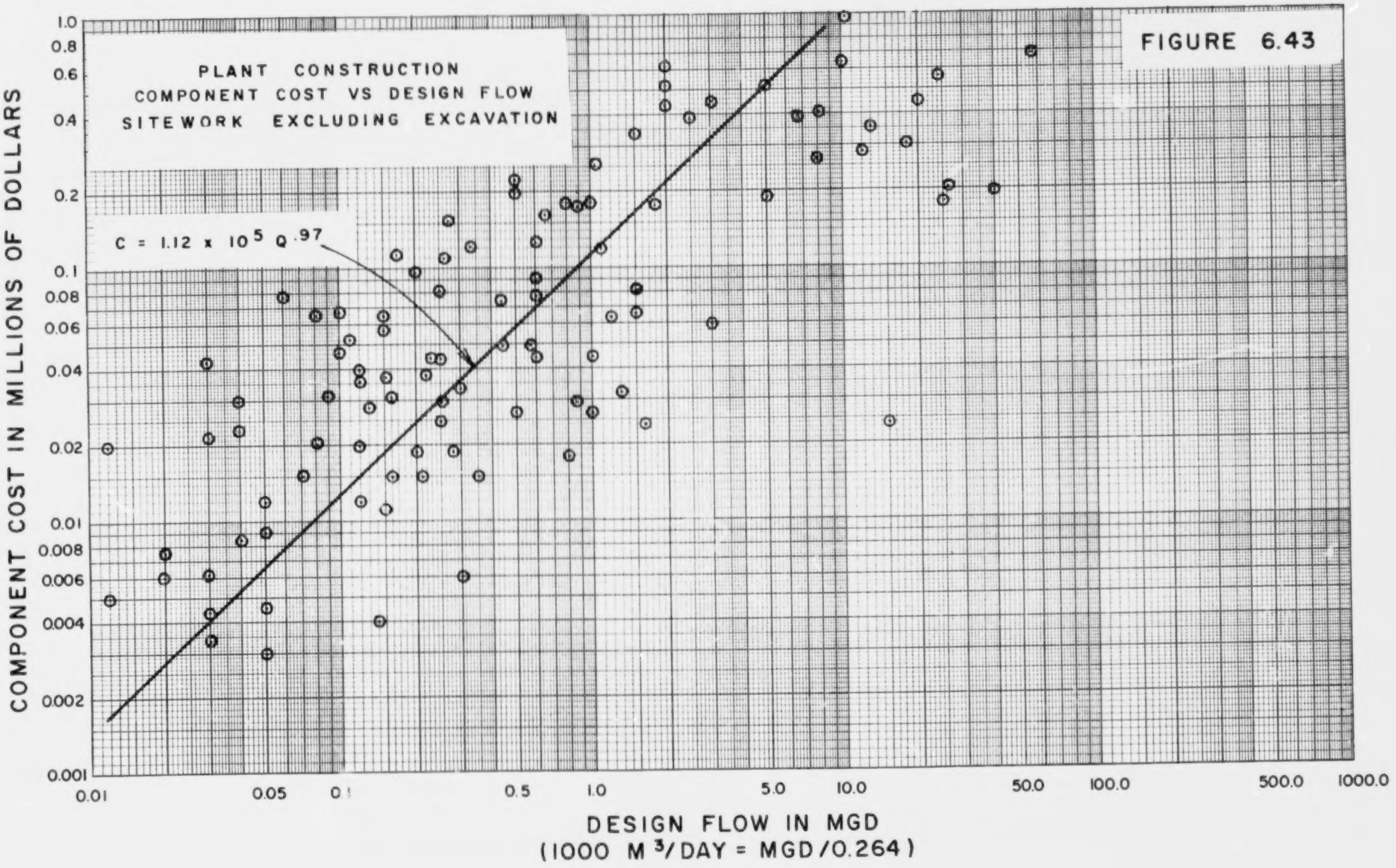


FIGURE 6.43

PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
SITEWORK EXCLUDING EXCAVATION

88-9

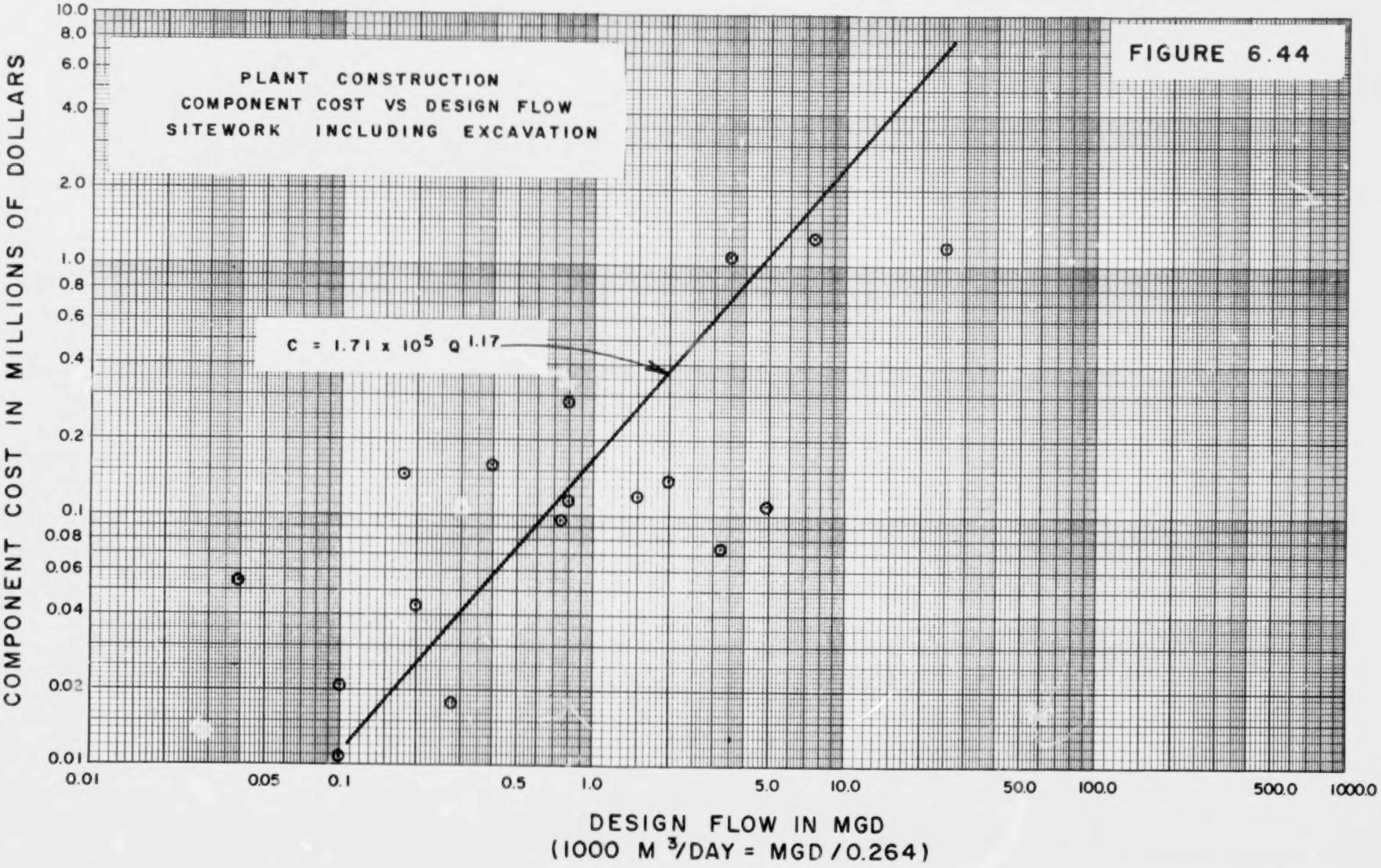


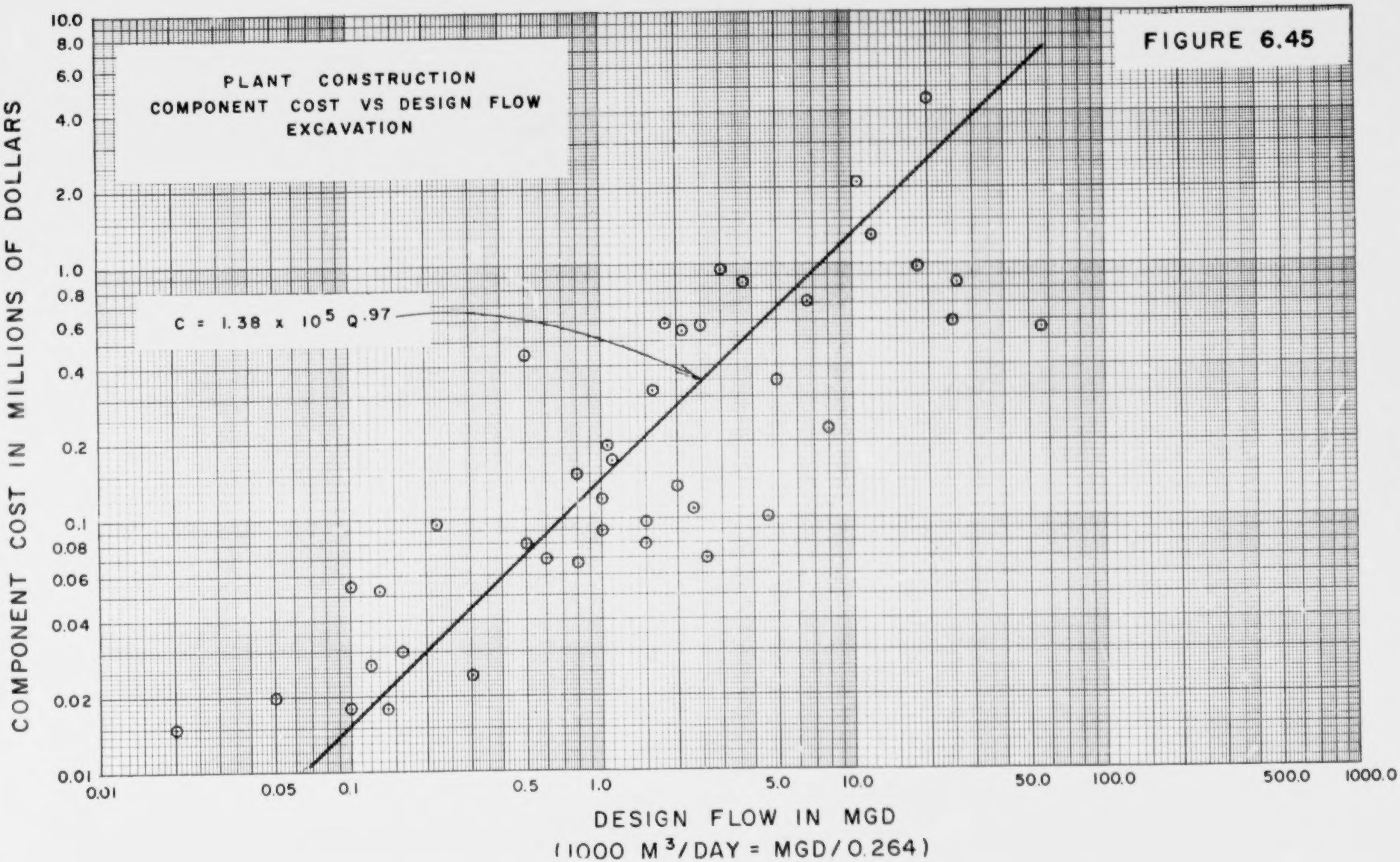
FIGURE 6.44

PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
SITEWORK INCLUDING EXCAVATION

$C = 1.71 \times 10^5\ Q^{1.17}$

FIGURE 6.45

PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
EXCAVATION



6-90

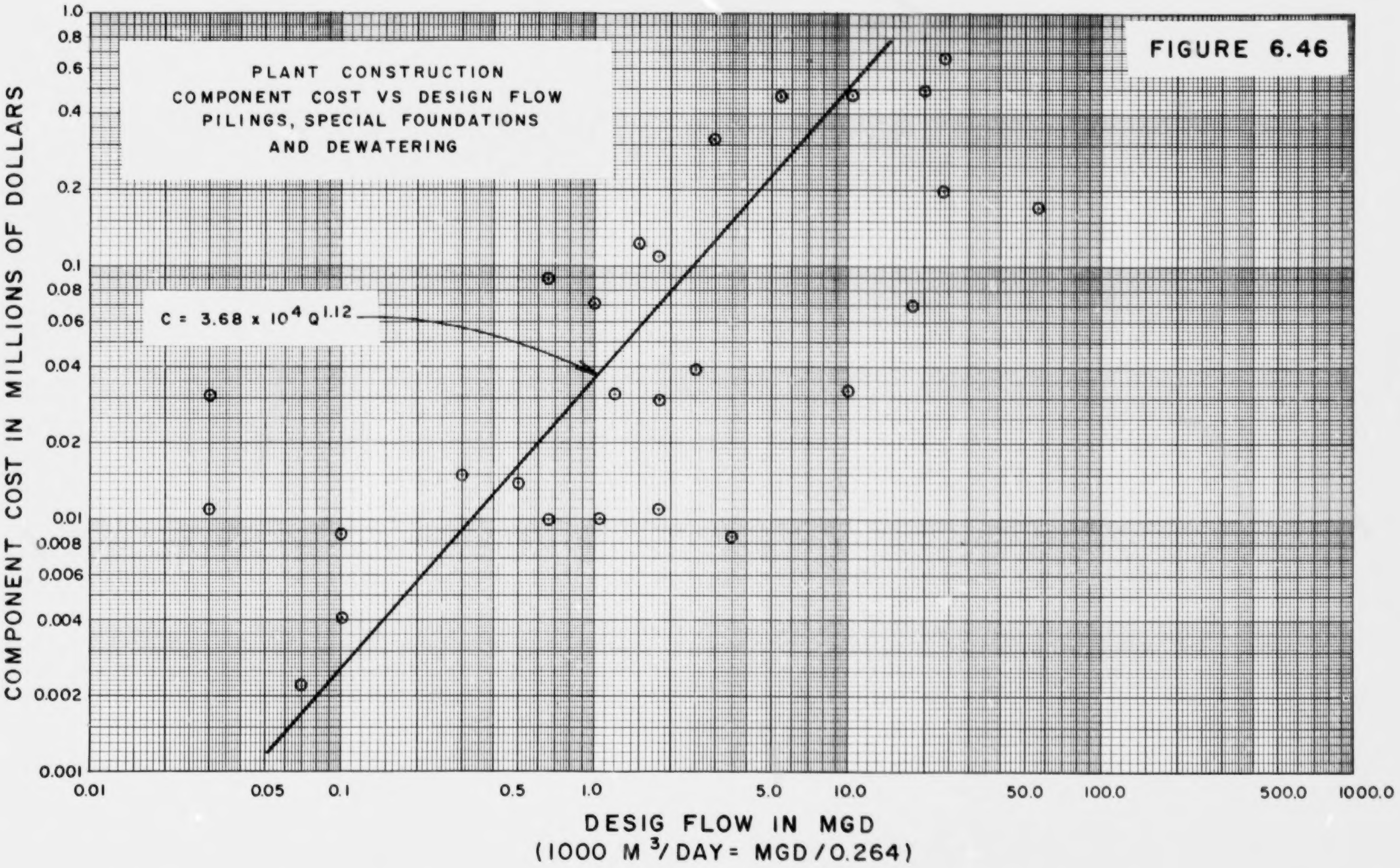
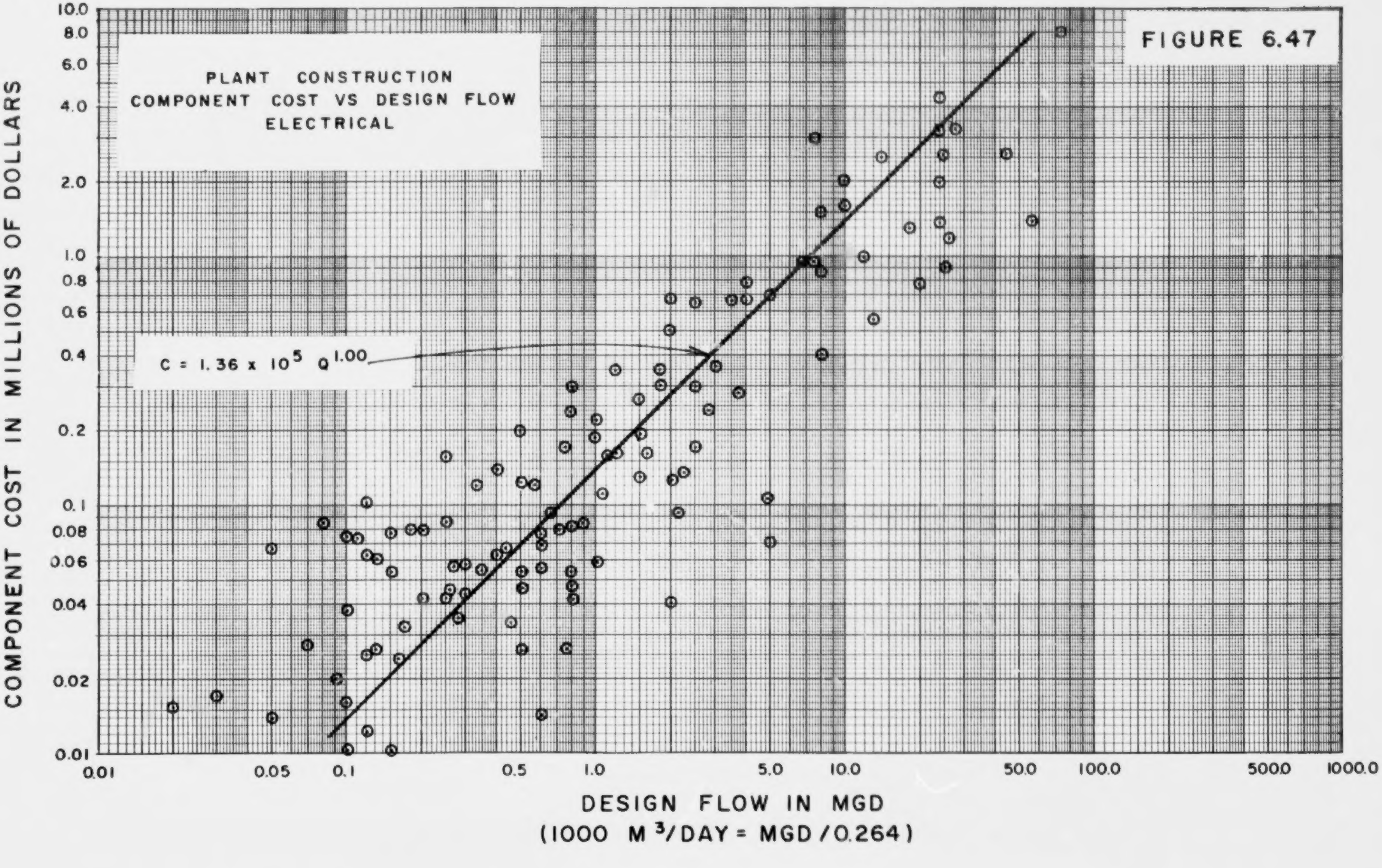


FIGURE 6.46

PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
PILINGS, SPECIAL FOUNDATIONS
AND DEWATERING

FIGURE 6.47


PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
ELECTRICAL
$C = 1.36 \times 10^5 Q^{1.00}$
COMPONENT COST IN MILLIONS OF DOLLARS
10.0
8.0
6.0
4.0
2.0
1.0
0.8
0.6
0.4
0.2
0.1
0.08
0.06
0.04
0.02
0.01
0.01
0.05
0.1
0.5
1.0
5.0
10.0
50.0
100.0
500.0
1000.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD / 0.264)

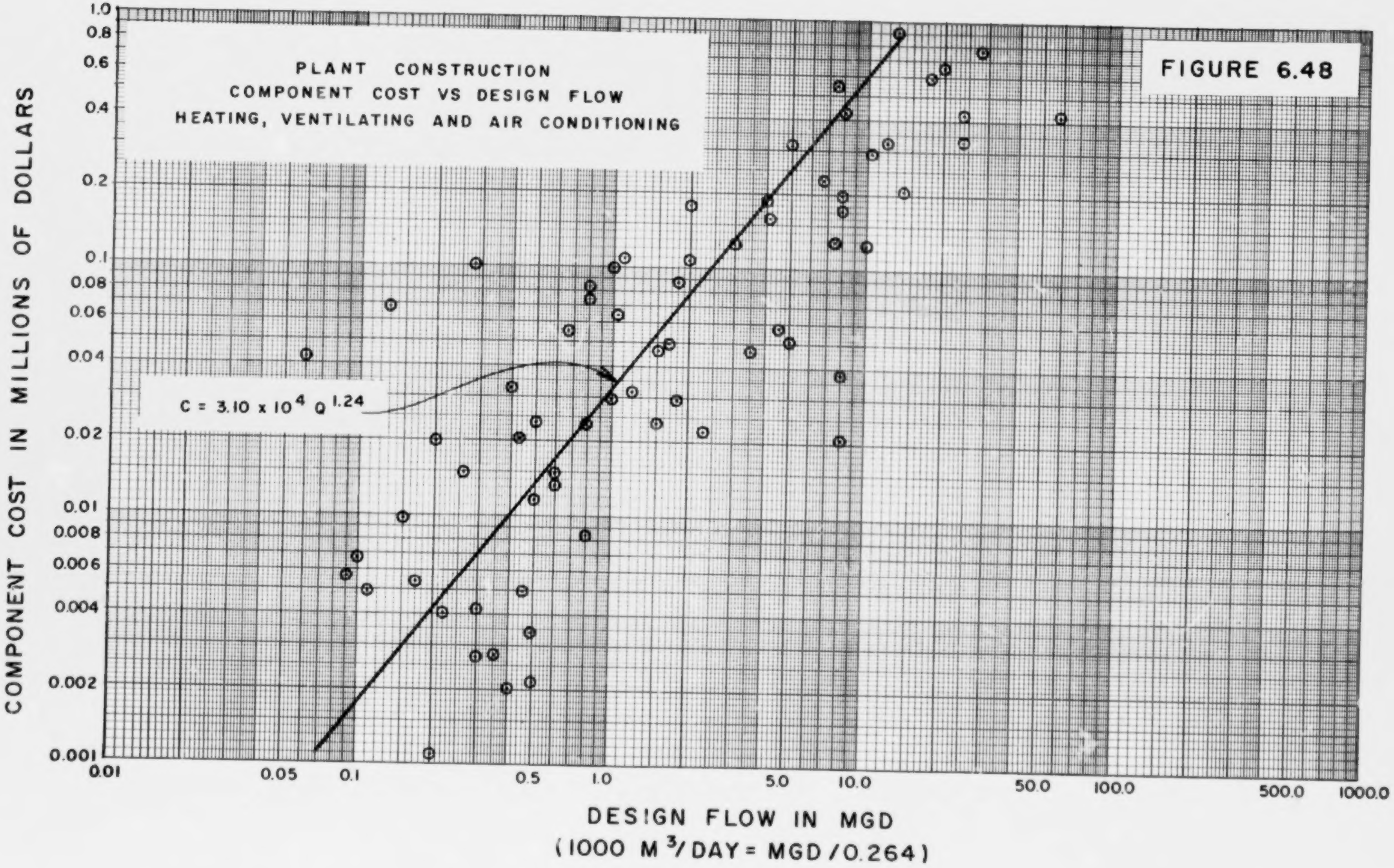
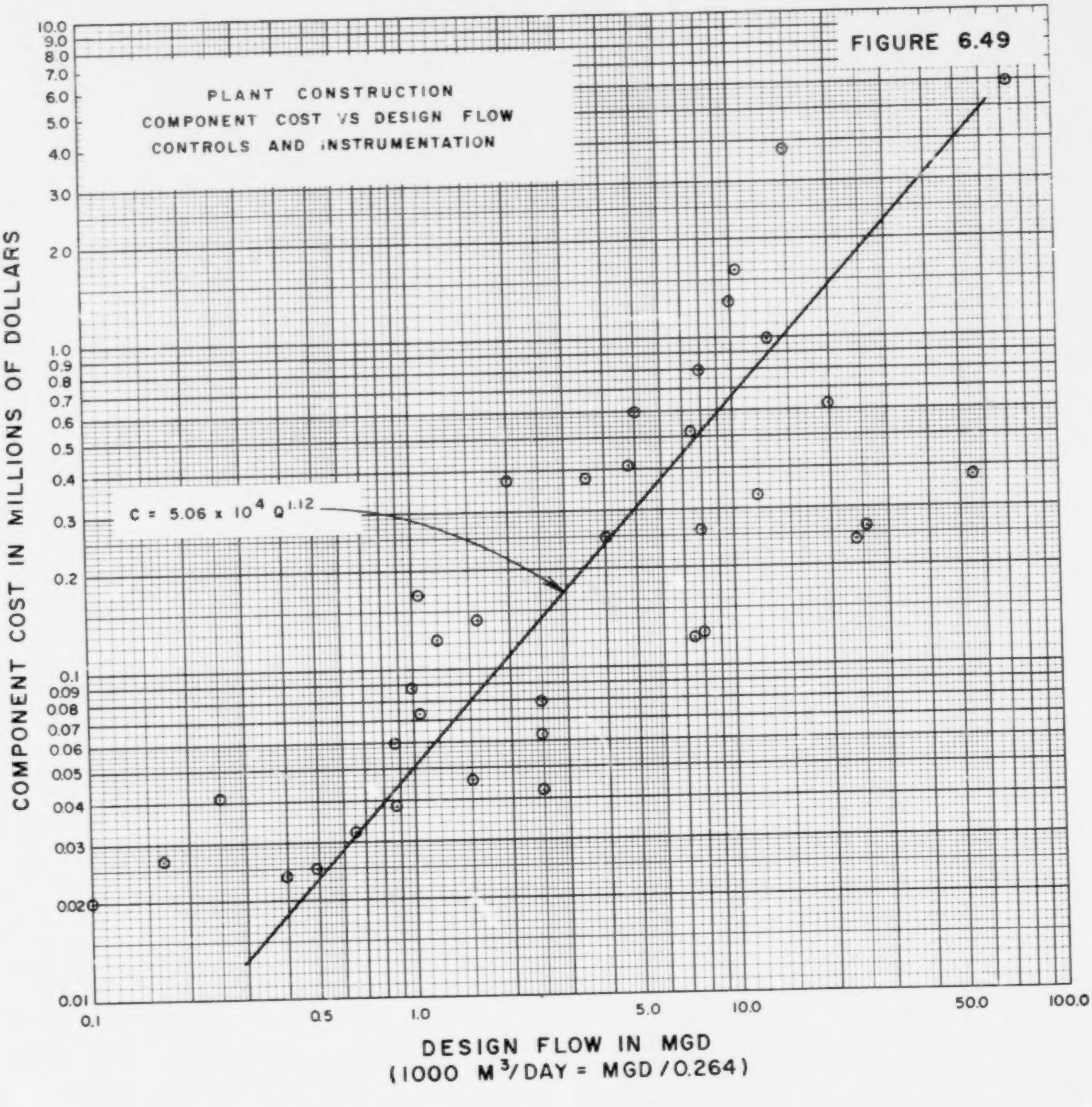


FIGURE 6.48

PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
HEATING, VENTILATING AND AIR CONDITIONING

FIGURE 6.49



PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
CONTROLS AND INSTRUMENTATION
C = 5.06 x 10^4 Q^1.12
COMPONENT COST IN MILLIONS OF DOLLARS
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0

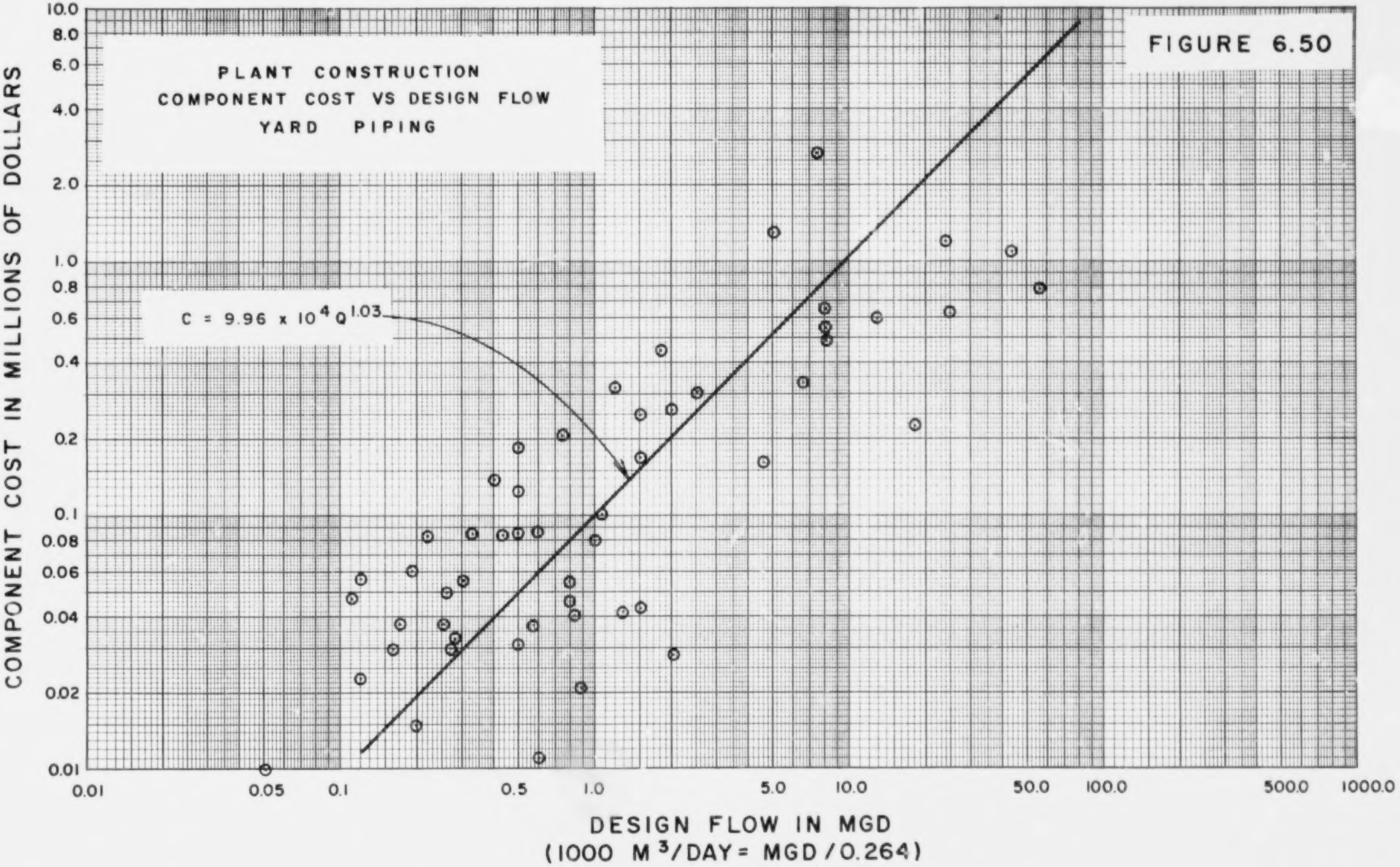


FIGURE 6.50

PLANT CONSTRUCTION
COMPONENT COST VS DESIGN FLOW
YARD PIPING

THIRD ORDER COST CURVES

(PROCESS CONSTRUCTION COMPONENT COSTS)

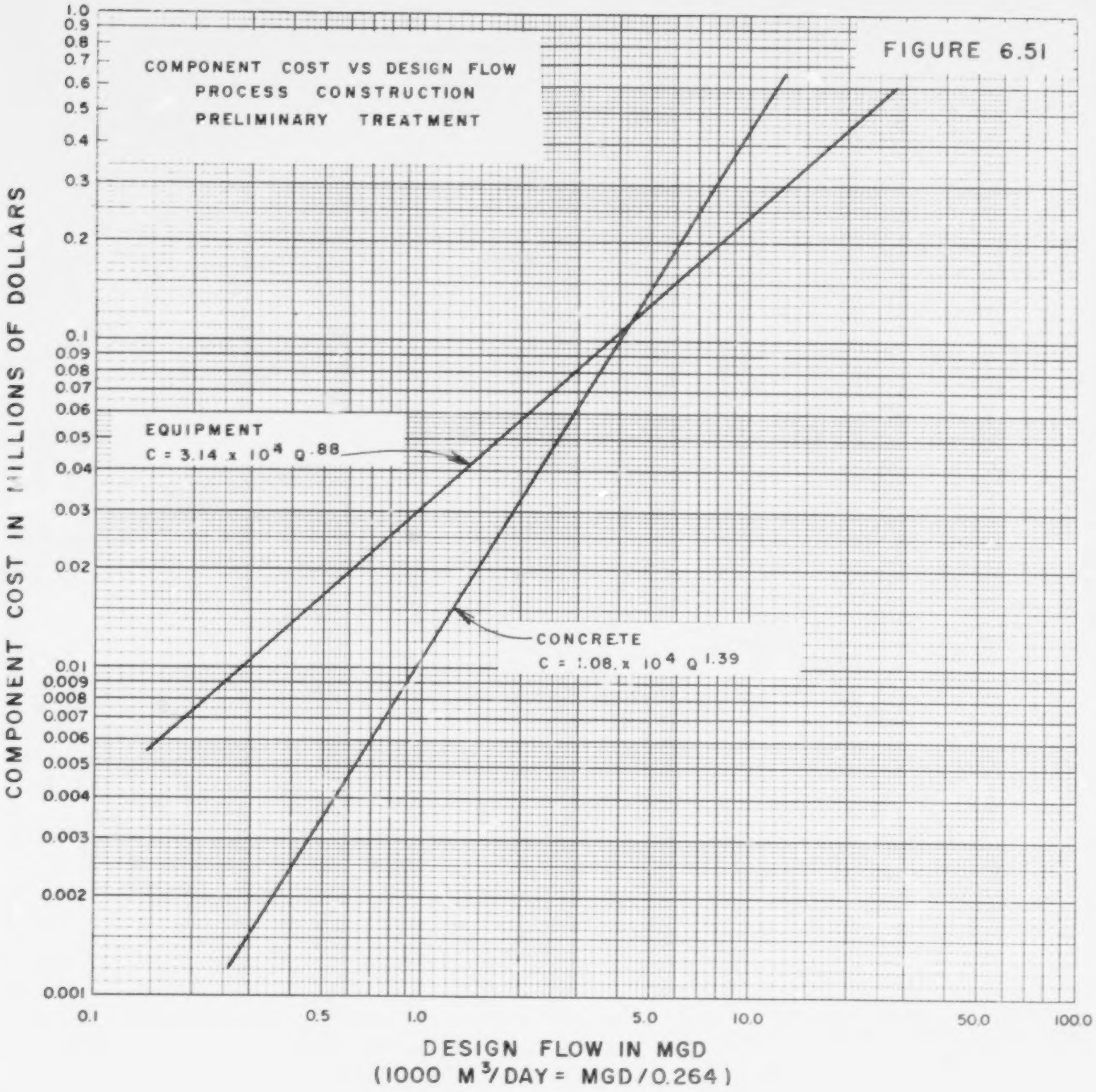


FIGURE 6.51

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
PRELIMINARY TREATMENT

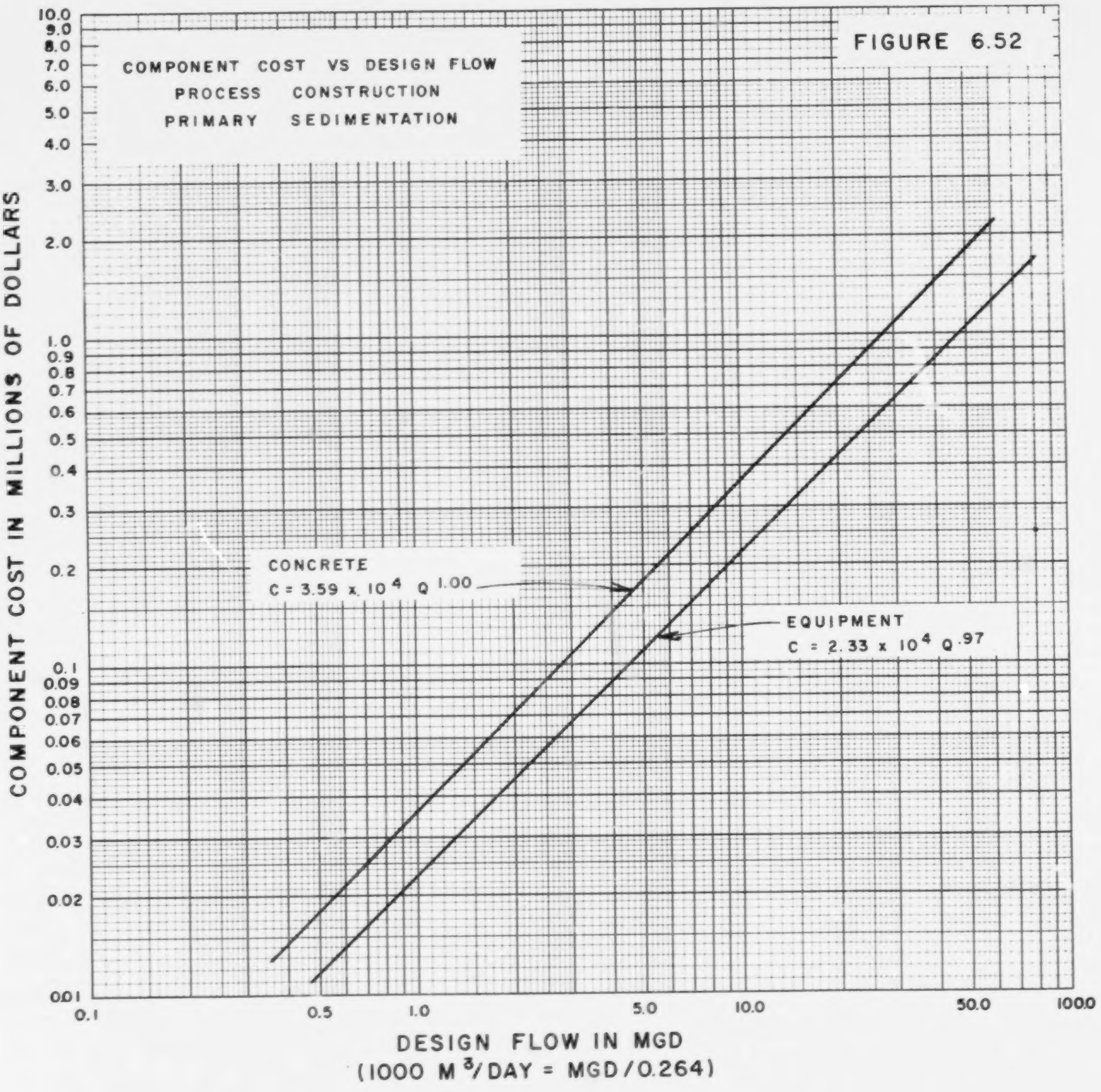
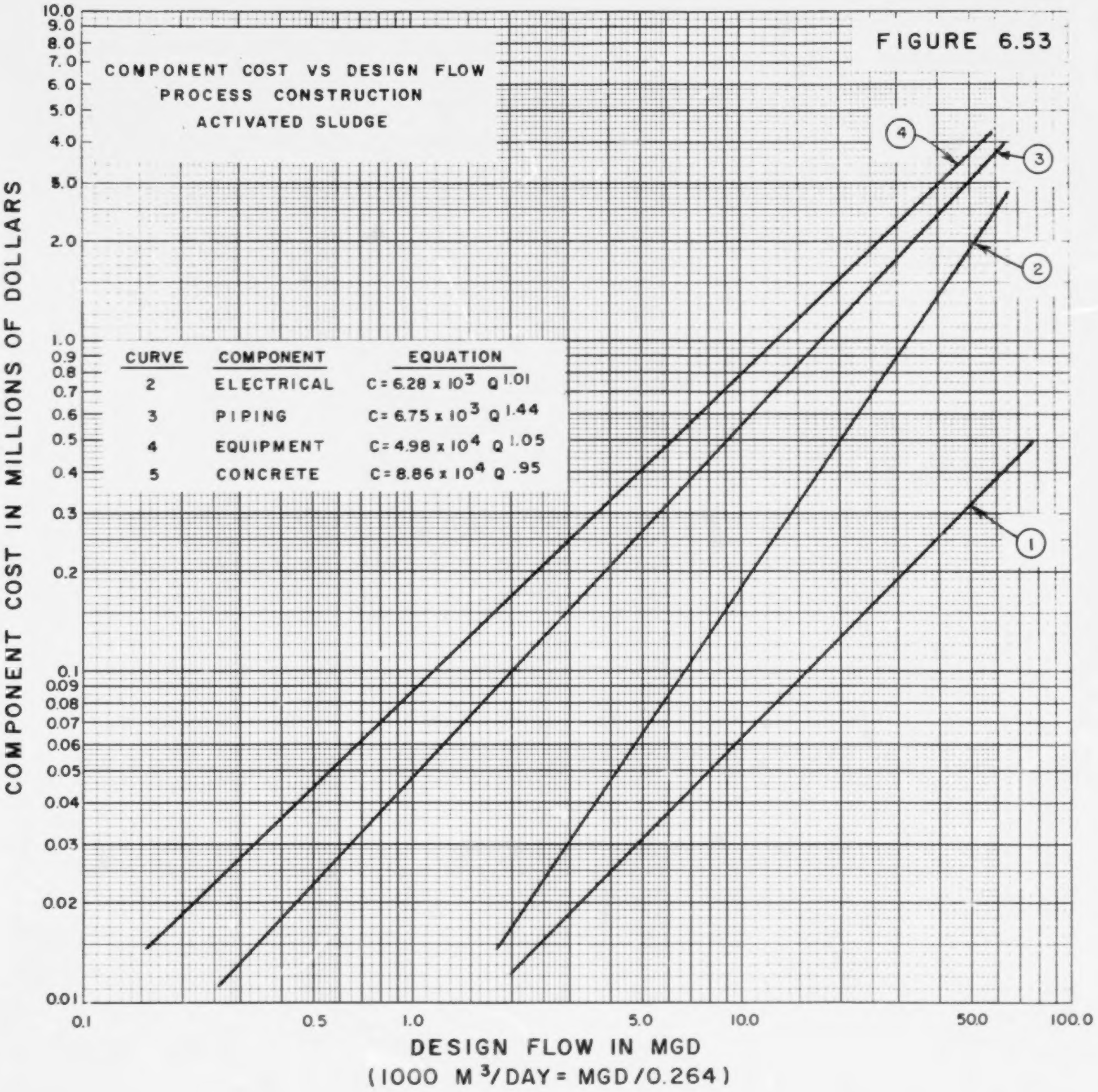


FIGURE 6.52
COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
PRIMARY SEDIMENTATION
CONCRETE
C = 3.59 x 10^4 Q^1.00
EQUIPMENT
C = 2.33 x 10^4 Q^.97
COMPONENT COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M3/DAY = MGD/0.264)

FIGURE 6.53

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
ACTIVATED SLUDGE



CURVE	COMPONENT	EQUATION
2	ELECTRICAL	$C = 6.28 \times 10^3\ Q^{1.01}$
3	PIPING	$C = 6.75 \times 10^3\ Q^{1.44}$
4	EQUIPMENT	$C = 4.98 \times 10^4\ Q^{1.05}$
5	CONCRETE	$C = 8.86 \times 10^4\ Q^{.95}$

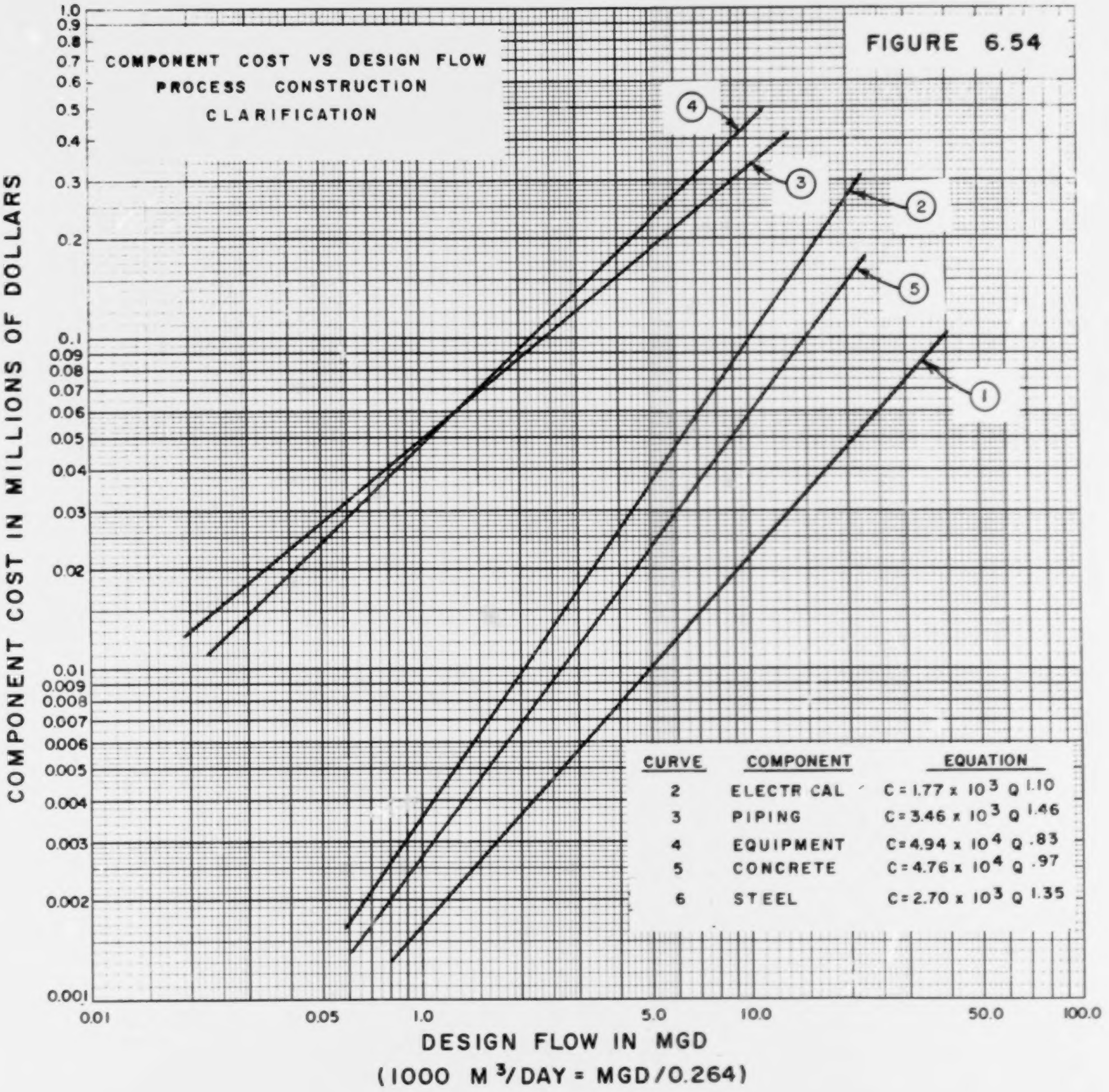


FIGURE 6.54

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
CLARIFICATION

CURVE	COMPONENT	EQUATION
2	ELECTRICAL	$C = 1.77 \times 10^3 Q^{1.10}$
3	PIPING	$C = 3.46 \times 10^3 Q^{1.46}$
4	EQUIPMENT	$C = 4.94 \times 10^4 Q^{.83}$
5	CONCRETE	$C = 4.76 \times 10^4 Q^{.97}$
6	STEEL	$C = 2.70 \times 10^3 Q^{1.35}$

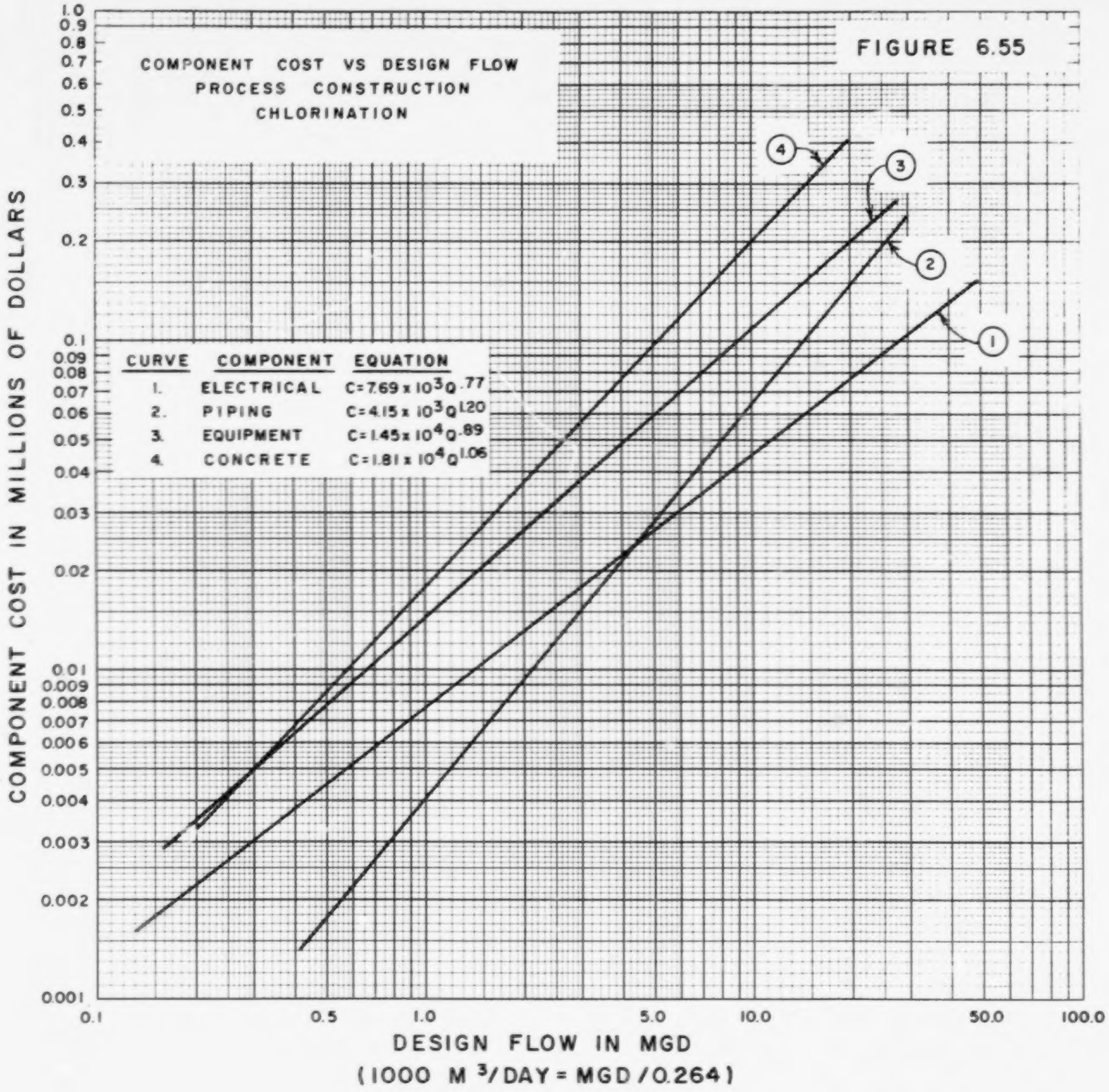


FIGURE 6.55

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
CHLORINATION

CURVE	COMPONENT	EQUATION
1.	ELECTRICAL	$C=7.69\times10^{3}Q^{.77}$
2.	PIPING	$C=4.15\times10^{3}Q^{1.20}$
3.	EQUIPMENT	$C=1.45\times10^{4}Q^{.89}$
4.	CONCRETE	$C=1.81\times10^{4}Q^{1.06}$

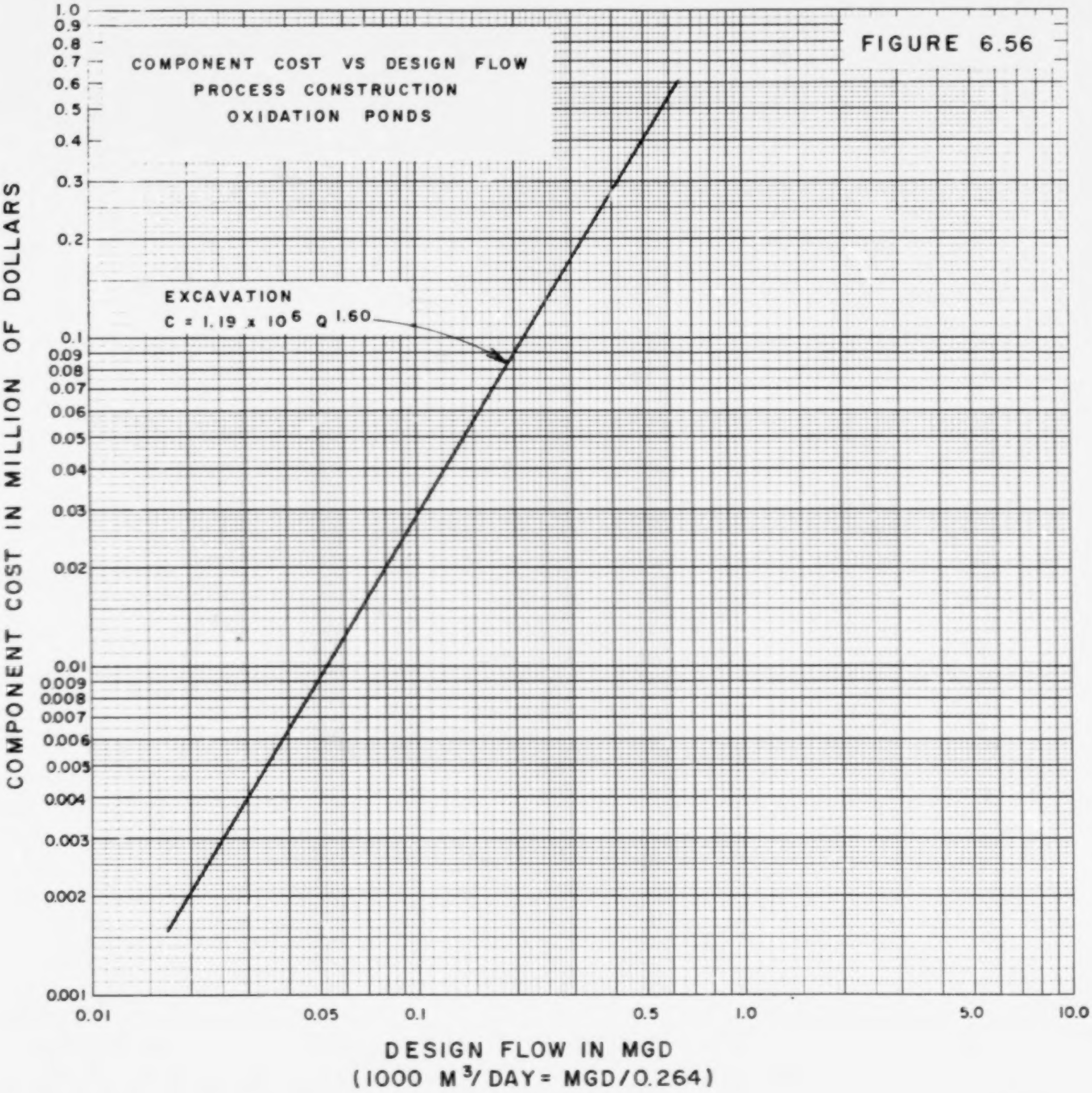


FIGURE 6.56

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
OXIDATION PONDS

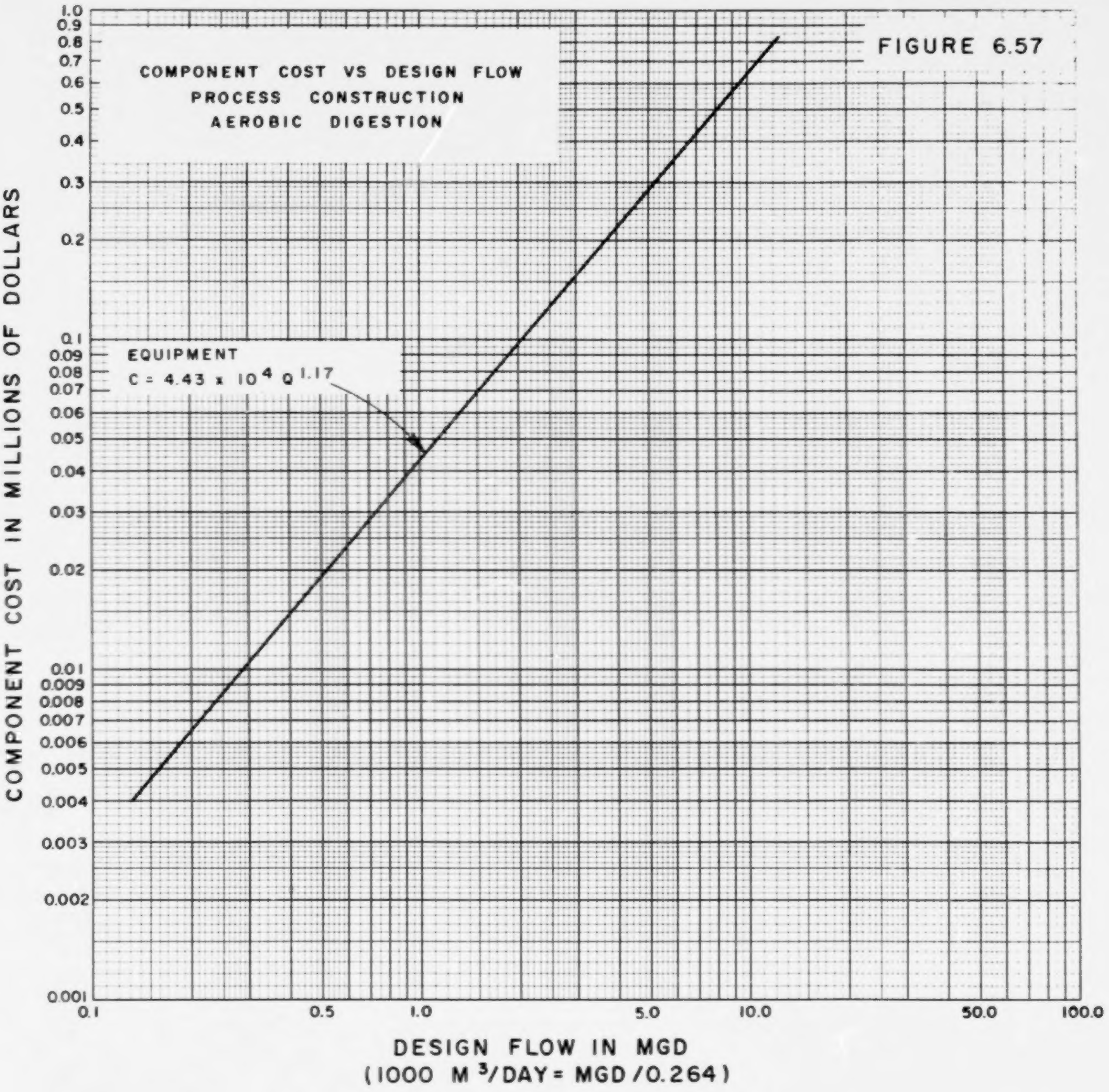
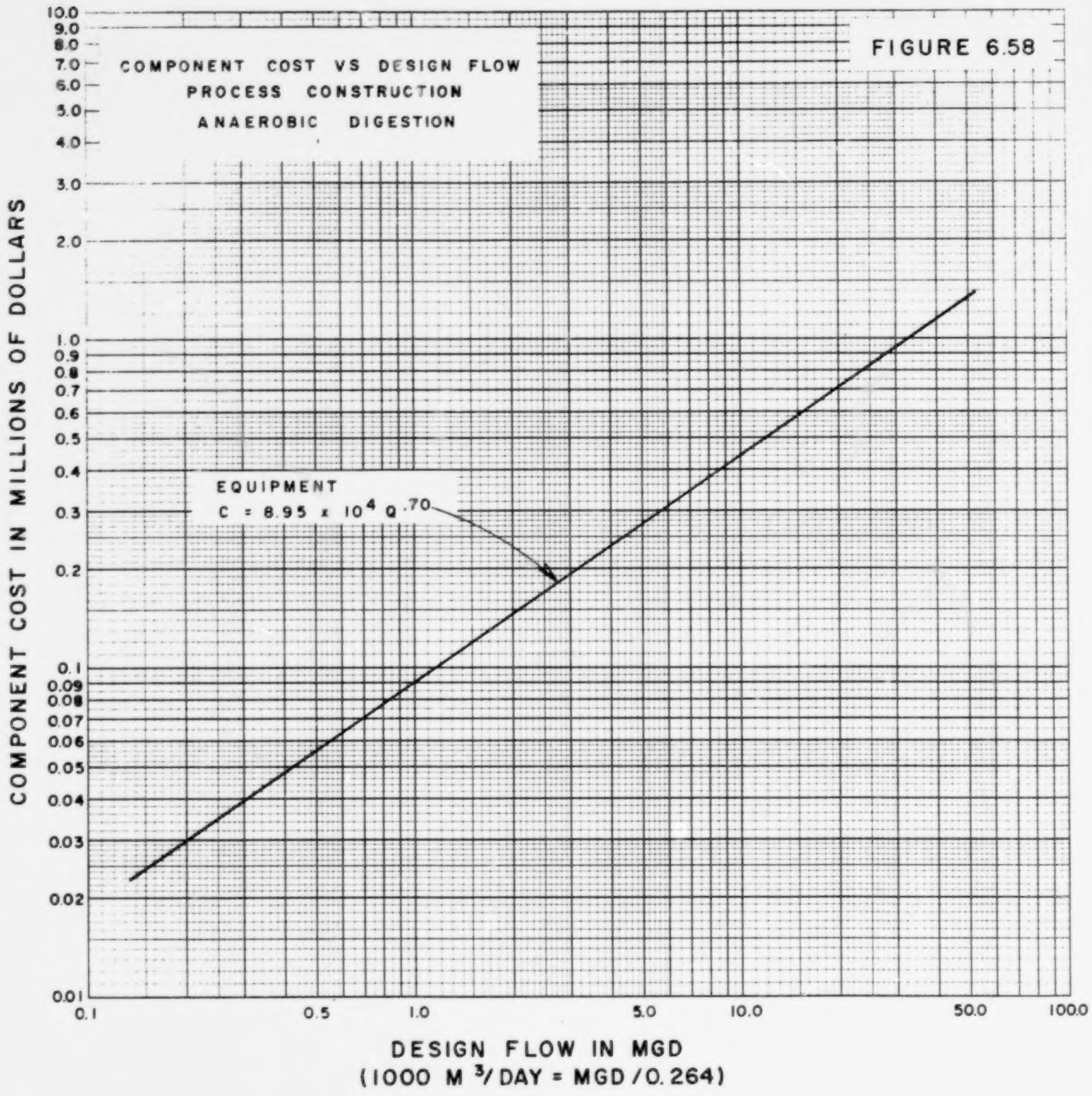


FIGURE 6.57

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
AEROBIC DIGESTION


COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
ANAEROBIC DIGESTION
FIGURE 6.58
EQUIPMENT
$C = 8.95 \times 10^4 Q^{.70}$
COMPONENT COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M^3/DAY = MGD/0.264)

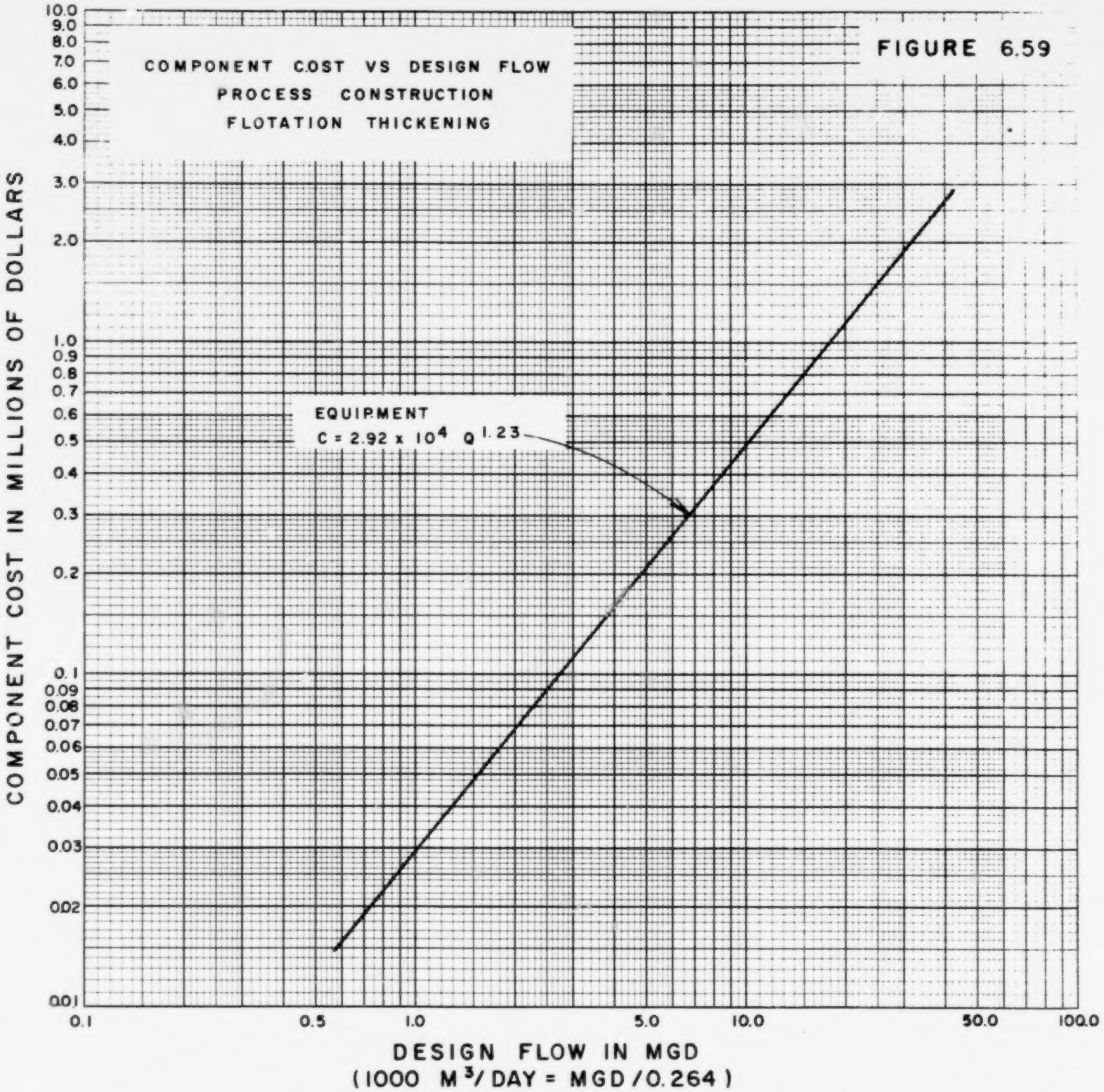


FIGURE 6.59
COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
FLOTATION THICKENING
EQUIPMENT
C = 2.92 x 10⁴ Q¹·²³
COMPONENT COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/ DAY = MGD / 0.264)

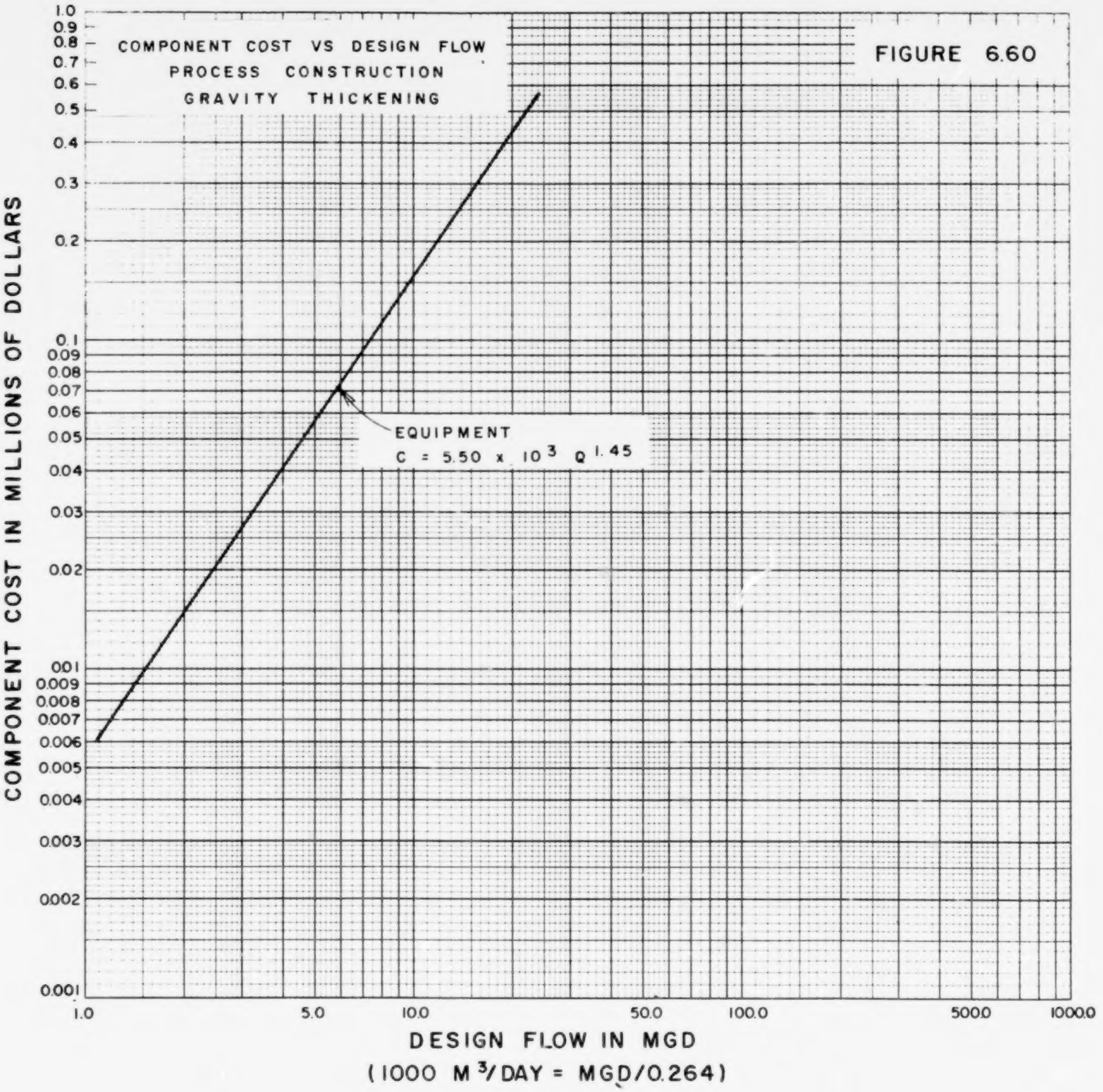
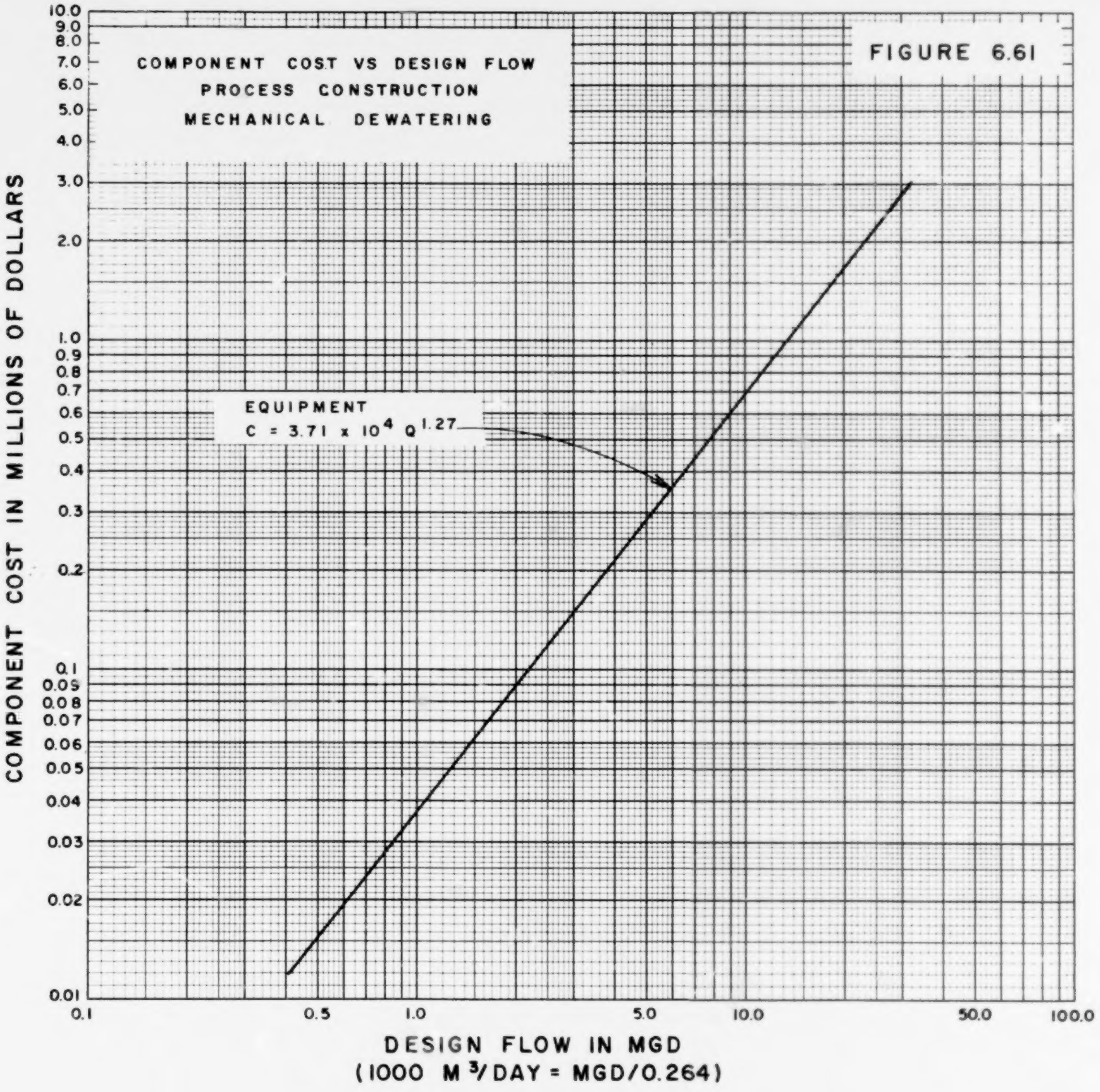
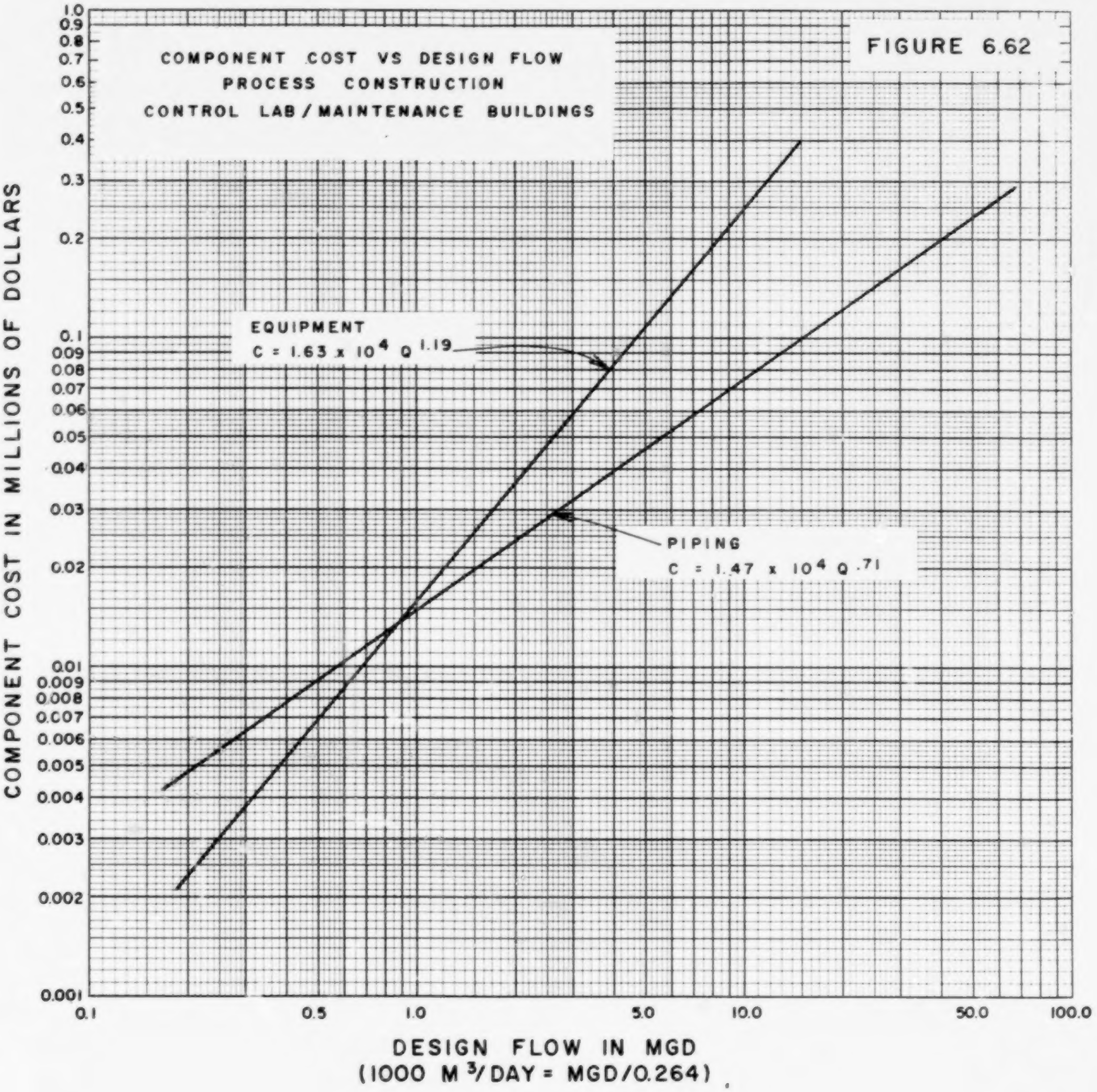


FIGURE 6.60

COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
GRAVITY THICKENING


COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
MECHANICAL DEWATERING
FIGURE 6.61
EQUIPMENT
C = 3.71 x 10⁴ Q¹·²⁷
COMPONENT COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)


COMPONENT COST VS DESIGN FLOW
PROCESS CONSTRUCTION
CONTROL LAB / MAINTENANCE BUILDINGS
FIGURE 6.62
EQUIPMENT
C = 1.63 x 10⁴ Q 1.19
PIPING
C = 1.47 x 10⁴ Q .71
COMPONENT COST IN MILLIONS OF DOLLARS
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.1
0.5
1.0
5.0
10.0
50.0
100.0
DESIGN FLOW IN MGD
(1000 M³/DAY = MGD/0.264)

7.0 SIMPLIFIED TREATMENT PLANT COST ESTIMATION TECHNIQUES

7.0 SIMPLIFIED TREATMENT PLANT COST ESTIMATION TECHNIQUES

7.1 Background

The Environmental Protection Agency in accordance with Sections 516(b)(2) and 205(a) of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), must submit a report to Congress before February 10, 1979 entitled "1978 Cost Estimates for the Construction of Publicly-Owned Wastewater Treatment Facilities." Commonly referred to as the "Needs Survey," similar reports have been submitted to Congress in 1974, 1975 and 1977.

The major objective of the 1978 Needs Survey is to provide a comprehensive estimate of the total cost of meeting the water pollution control goals of the act. To accomplish this objective cost estimates of treatment needs will be developed on a facility by facility basis for each existing or planned treatment plant nationwide.

In the process of developing cost estimates for new or enlarged and/or upgraded facilties, the most accurate cost information is to be employed. A majority of the facilities reviewed will have cost information available based on completed Step I facilities planning or other similar engineering criteria. However, in many cases specific plans and cost estimates will not have been developed.

One of the objectives of the present study was to provide construction cost estimating criteria to be used in the 1978 Needs Survey for facilities in this latter case. In developing cost estimates for these treatment plants based on previous bid data three criteria were considered of importance:

1. The resultant cost curves and procedures had to be broad in scope applicable to a wide range of treatment alternatives from small, evaporation lagoons to large AWT mechanical plants.

2. Cost estimating methods had to be flexible enough to be applied coast to coast yet technically consistent providing national uniformity.

3. Methods were to be straightforward, facilitating utilization by a variety of users.

Using these criteria Figures 7.1 through 7.4 were produced using the data base described in Section 6.0 of this report. Costs presented in these figures have been updated to first quarter 1978 dollars using the EPA Treatment Plant Indices. In addition the 1978 Needs Survey curves include allowances for Step I and Step II costs as well as Step III non-construction costs such as administrative, legal, inspection and contingency expenses. For these reasons, Needs Survey curves will vary considerably from related cost curves presented in Section 6.0 which include construction cost only. These cost estimating procedures are presented in the belief that the lay public often has need to estimate treatment plant construction costs.

7.2 Treatment Plant Costs

Figure 7.1 presents curves used for estimating costs for mechanical wastewater treatment plants. Note that the cost scales differ for the left and right halves of the graph. Curve 1 is used for secondary treatment facilities. This curve was developed from approximately 100 construction cost bids for plants nationwide. It reflects costs for both activated sludge and trickling filter secondary facilities.

When a plant is required to produce effluent concentrations less than 30 mg/l each for both suspended solids and BOD or greater than 85 percent removal for these pollutants, Curve 2 should be employed for cost estimating.

Construction bid information was collected for plants requiring phosphorus removal in addition to secondary treatment. The linear regression best fit for these points when superimposed on the secondary treatment cost curve was askew to and significantly below the secondary curve with the difference increasing with increasing design flow. For the purposes of the Needs Survey, Curve 1 was assumed to apply to secondary treatment with phosphorus removal as well as secondary treatment only.

A similar trend was observed in development of Curve 3 for greater than secondary treatment with nutrient removal. Data for these facilties produced a line which crossed the curve for greater than secondary at about 5.0 MGD design flow becoming less costly at higher design flows. For this reason Curve 2 represents both categories above 5.0 MGD.

For instances in which existing facilities must be enlarged and/or upgraded, costs are to be determined by using the new construction cost for the projected design flow from the appropriate curve and deducting an allowance for the usable portions of the existing plant. Curves A and B provide deduction values for existing primary and secondary plants, respectively.

Curve A was developed by subtracting from the secondary treatment, new construction curve (Curve 1) the cost of upgrading facilities from primary to secondary treatment. Similarly, Curve B is the result of subtracting the cost of upgrading secondary treatment facilities to advanced wastewater treatment (AWT) from the cost of new AWT plants.

7.2.1 Aerated Lagoons and Stabilization Ponds

For many of the proposed facilities which require needs estimates, stabilization ponds or aerated lagoons are suitable, lower cost alternatives as treatment processes. In these cases Figure 7.2 should be used to estimate costs. Analysis of construction projects nationwide indicates that very few aerated lagoons are built with design flows less than about 0.2 MGD. Correspondingly, few stabilization ponds have design flows greater than 0.2 MGD. For these reasons, curves for both aerated lagoons and stabilization ponds were combined on Figure 7.2 with costs at higher design flows reflecting aerated lagoon bid data and costs at lower design flows data from stabilization pond projects.

In addition, due to the variation in lagoon design parameters resulting from variations in climatic conditions, data were segregated into warm and cold climate facilities and curves developed for each. While the 38th parallel of north latitude was used for this study, in practice one should consider local climatic variations such as elevation and effects of ocean air currents in determining which curve is more appropriate.

Costs are included in the lagoon curves for preliminary treatment and chlorination as well as average costs for pumping, lining, and laboratory/maintenance facilities.

Figure 7.3 presents costs for adding phosphorus removal facilities to existing wastewater treatment plants. This curve is not meant for use with new treatment plants.

Because many facilities were originally constructed without effluent chlorination capabilities, Figure 7.4 was derived from unit process cost data to provide for the expense of adding this process. New treatment plant costs from Figure 7.1 include a chlorination allowance.

7.3 City Multipli[illegible]

To better re[illegible] the variations in wastewater treatment plant construction costs due to regional differences in material and labor costs, the geographic multipliers indicated on Table 7.1 were developed.

These multipliers were derived from engineers' estimates for treatment plants nationwide as reported in the 1976 Needs Survey.

Map 7.1 was drawn by correlating wage information based on Bureau of Labor Statistics data for 102 cities with the wage rate data for which city multipliers were available. State and county boundaries were followed where possible with labor rate correlations indicating general areas of influence for the 46 cities listed in Table 7.1. This map is to be used in conjunction with Table 7.1 for applying city multipliers to costs estimated using curves presented in this section. See the following section for examples of the use of this table.

7.4 Examples - Treatment Plant Cost Estimating

The following examples have been devised to illustrate treatment plant cost estimates using procedures outlined in this section. As noted, all cost curves include average allowances for Step I, Step II, and Step III non-construction item costs.

Example 1 - Enlarge and Upgrade, Secondary Plant

Enlarge and upgrade an existing 1.0 mgd primary sedimentation treatment plant to a 5.0 mgd secondary activated sludge plant in Ft. Collins, Colorado.

1. From Figure 7.1, Curve 1:	
Cost of 5.0 mgd Secondary Plant	$10,500,000
2. From Figure 7.1, Curve A:	
Deduction for 1.0 mgd Primary Plant	- 640,000
	$ 9,860,000
3. From Table 7.1: Denver City Multiplier	X 0.8843
Cost Estimate	$ 8,719,000

Example 2 - Enlarge Secondary Plant

Enlarge an existing secondary, activated sludge treatment plant in Omaha, Nebraska from 10.0 mgd to 45.0 mgd.

1. From Figure 7.1, Curve 1:	
Cost 45.0 mgd Secondary Plant	$75,000,000
2. From Figure 7.1, Curve B:	
Deduction for 10.0 mgd Secondary Plant	-19,500,000
	$55,500,000
3. From Table 7.1: Des Moines City Multiplier	X 0.8371
Cost Estimate	$46,460,000

Example 3 - New Secondary Plant

Construct a new 3.0 mgd secondary activated sludge treatment plant with phosphorus removal in Bath, Maine.

1. From Figure 7.1, Curve 1:	
Cost of 3.0 mgd Secondary Plant w/Phosphorus Removal	$ 6,700,000
2. From Table 7.1, Portland, Maine City Multiplier	X 1.1226
Cost Estimate	$ 7,520,000

Example 4 - Enlarge and Upgrade, AWT Plant

Enlarge and upgrade an existing 0.4 mgd secondary, activated sludge treatment plant to a 2.0 mgd greater than secondary plant with ammonia removal in Tacoma, Washington.

1. From Figure 7.1, Curve 3:	
Cost of 2.0 mgd Secondary w/Nut. Rem. Plant	$ 7,200,000
2. From Figure 7.1, Curve B:	
Deduction for 0.4 mgd Secondary Plant	- 940,000
	$ 6,260,000
3. From Table 7.1: Tacoma City Multiplier	X 1.0862
Cost Estimate	$ 6,800,000

Example 5 - Enlarge Aerated Lagoon

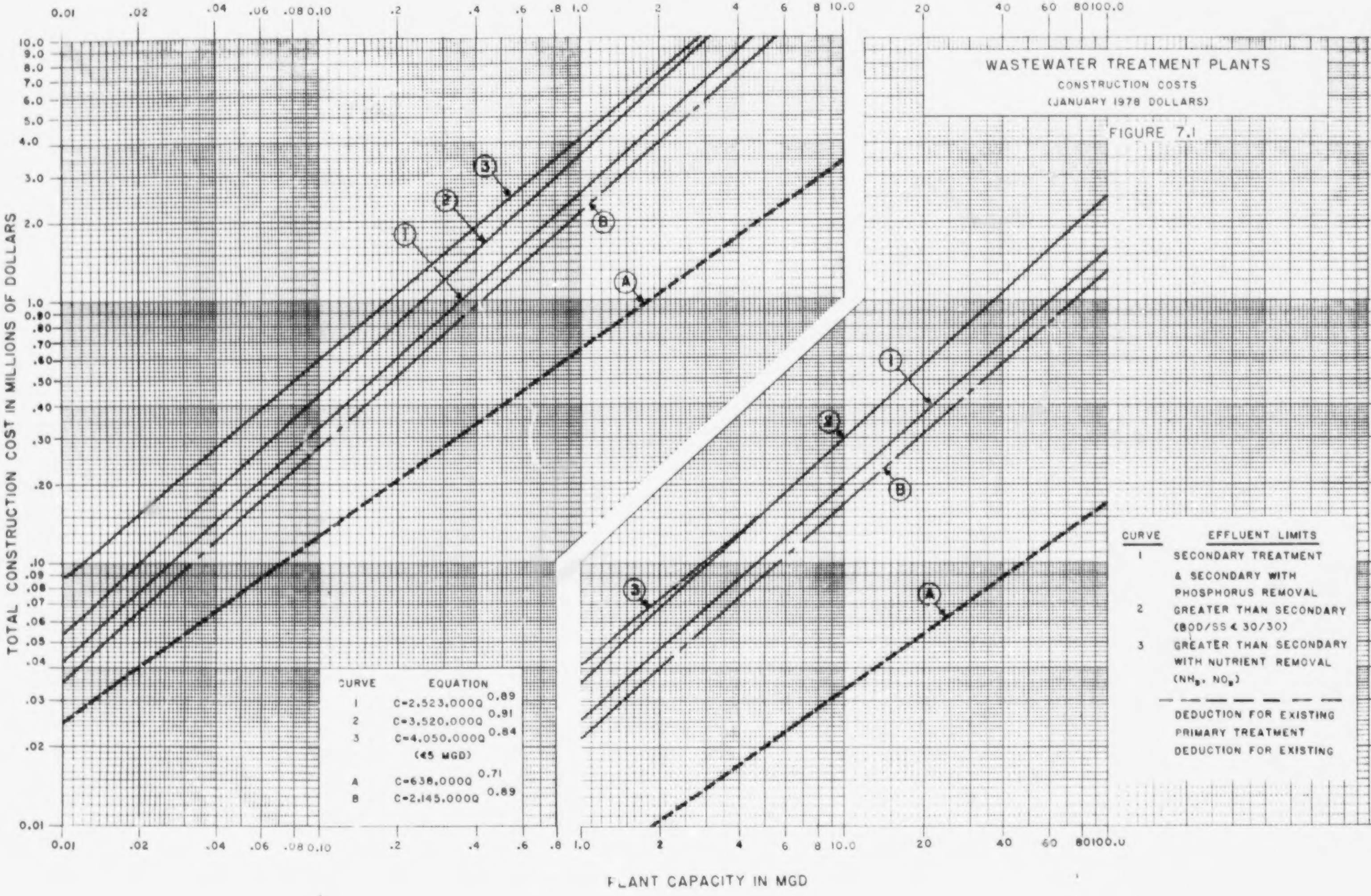
Enlarge an existing 0.10 mgd aerated lagoon in Twig, Minnesota to a 0.50 mgd secondary treatment, aerated lagoon.

1. From Figure 7.2, Cold Climate Curve:	
Cost of 0.50-0.10 = 0.40 mgd Aerated Lagoon	$ 1,140,000
2. From Table 7.1: Duluth City Multiplier	X 1.2468
Cost Estimate	$ 1,421,000

Example 6 - Upgrade Phosphorus Removal

Upgrade an existing 1.0 mgd Secondary, activated sludge treatment plant in Tampa, Florida to include phosphorus removal.

1. From Figure 7.3:	
Cost of 1.0 mgd Phosphorus Removal Process	$ 120,000
2. From Table 7.1: Miami, Florida City Multiplier	X 0.8843
Cost Estimate	$ 106,000



WASTEWATER TREATMENT PLANTS
CONSTRUCTION COSTS
(JANUARY 1978 DOLLARS)

FIGURE 7.1

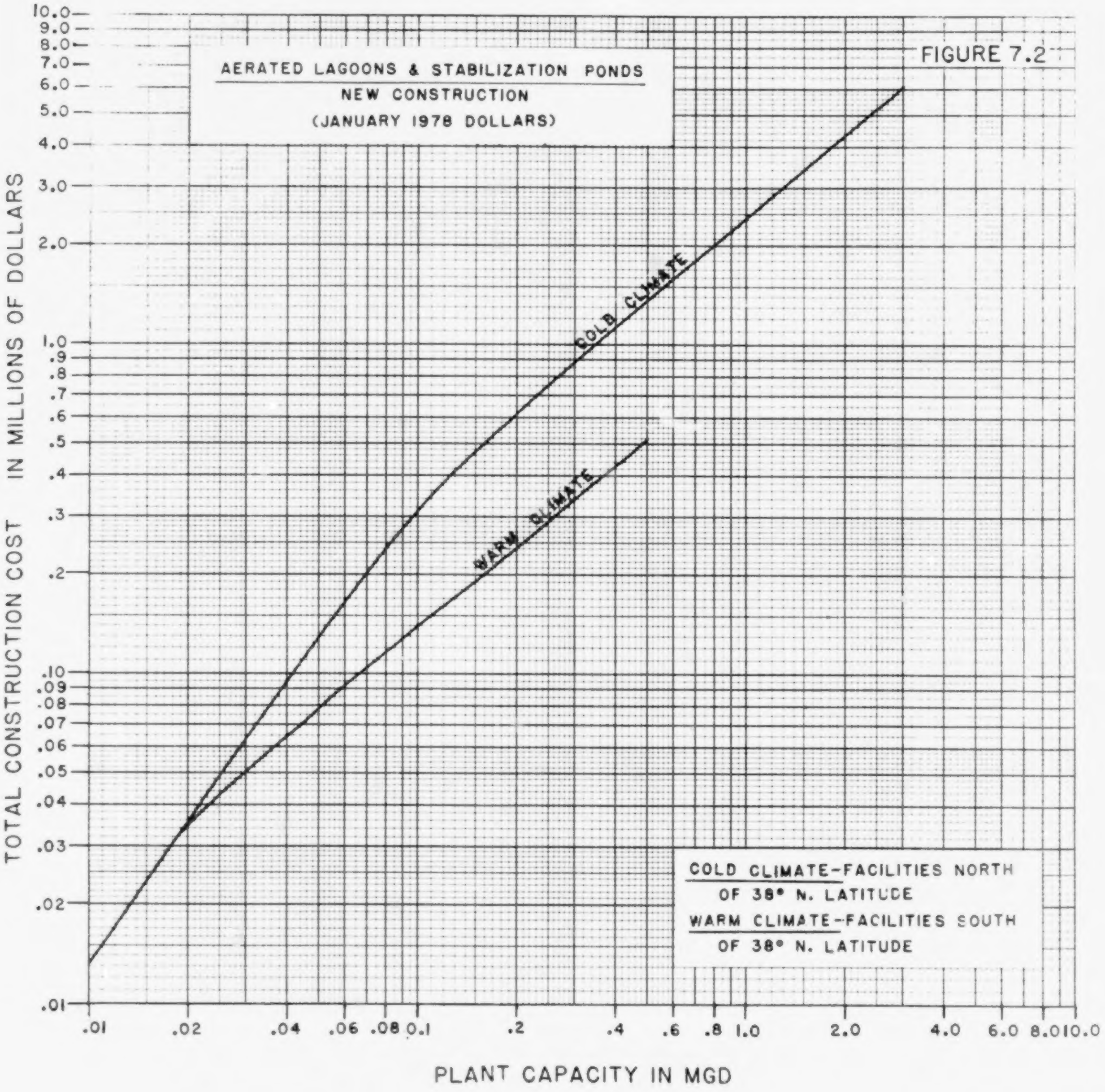


FIGURE 7.2
AERATED LAGOONS & STABILIZATION PONDS
NEW CONSTRUCTION
(JANUARY 1978 DOLLARS)
TOTAL CONSTRUCTION COST IN MILLIONS OF DOLLARS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.01
.02
.04
.06
.08
0.1
.2
.4
.6
.8
1.0
2.0
4.0
6.0
8.0
10.0
PLANT CAPACITY IN MGD
COLD CLIMATE
WARM CLIMATE
COLD CLIMATE-FACILITIES NORTH OF 38° N. LATITUDE
WARM CLIMATE-FACILITIES SOUTH OF 38° N. LATITUDE

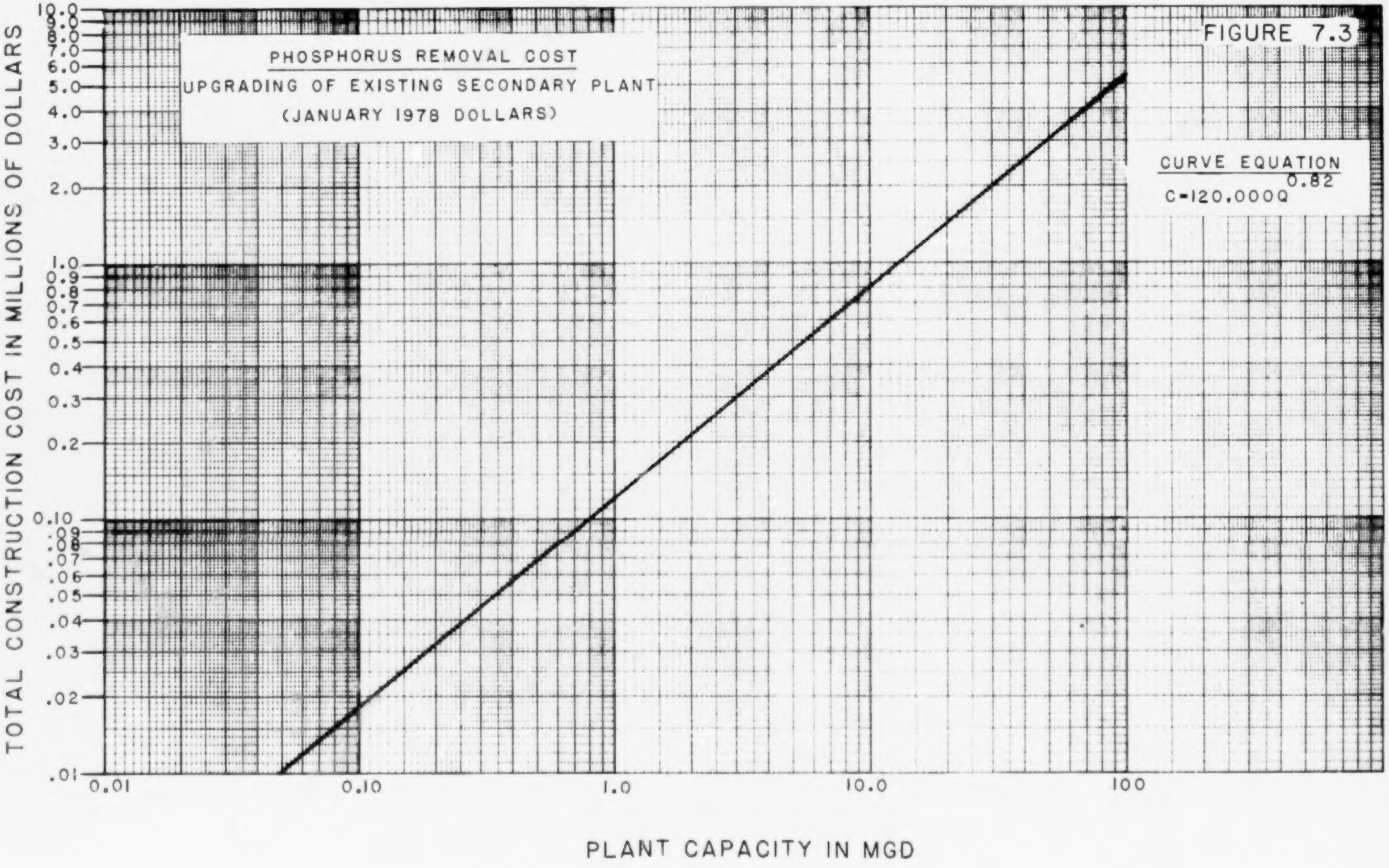


FIGURE 7.3

PHOSPHORUS REMOVAL COST

UPGRADING OF EXISTING SECONDARY PLANT

(JANUARY 1978 DOLLARS)

CURVE EQUATION

$C=120{,}000Q^{0.82}$

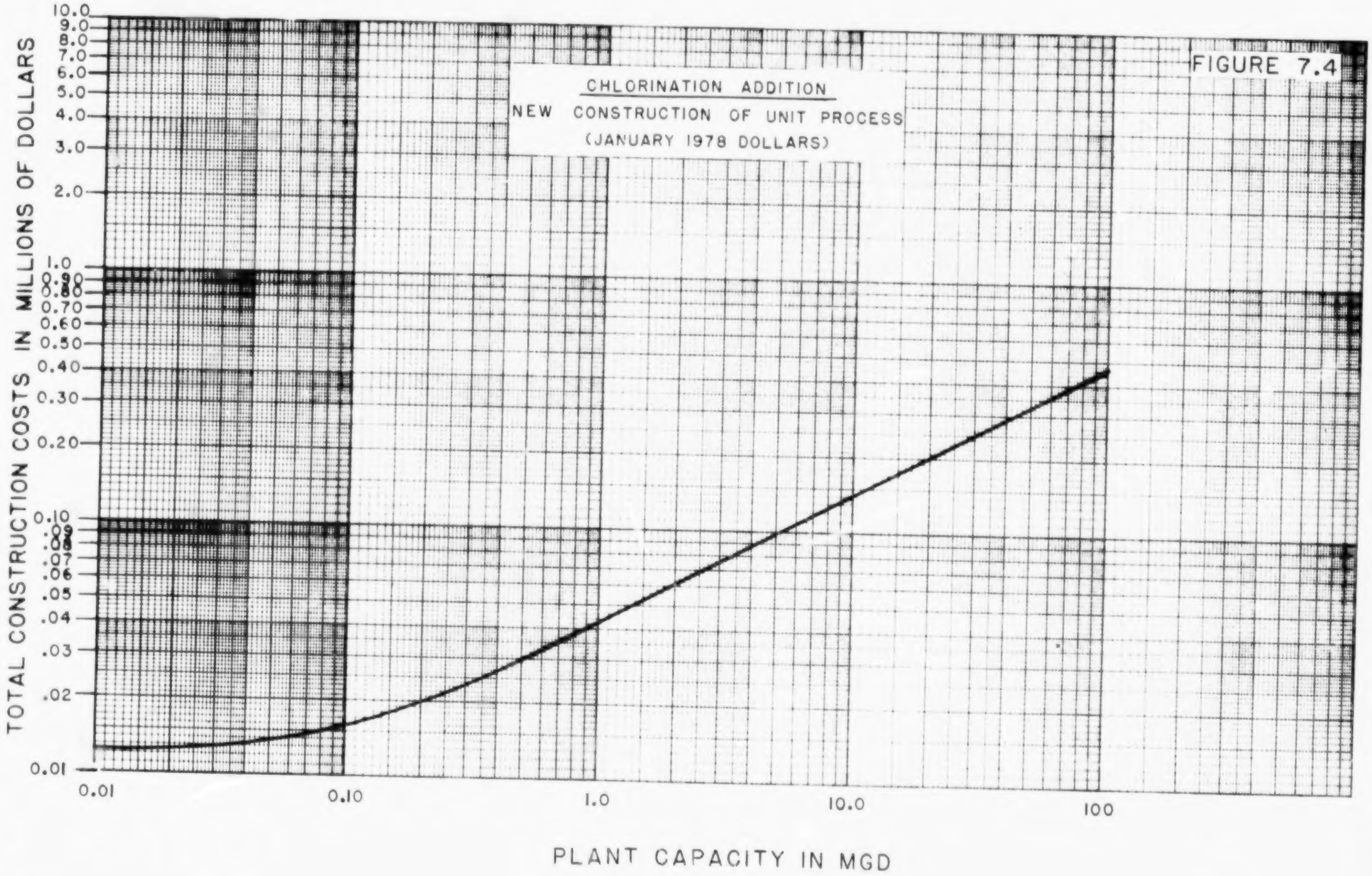


FIGURE 7.4

CHLORINATION ADDITION
NEW CONSTRUCTION OF UNIT PROCESS
(JANUARY 1978 DOLLARS)

TABLE 7.1

CITY MULTIPLIERS
WASTEWATER TREATMENT PLANT CONSTRUCTION

REFERENCE: MAP NO. 7.1

City Code (From Map No. 1)	City	Multiplier
1	Albany, New York	1.1985
2	Atlanta, Georgia	0.8347
3	Baltimore, Maryland	1.0083
4	Binghamton, New York	1.1722
5	Birmingham, Alabama	0.8289
6	Boston, Massachusetts	1.1349
7	Buffalo, New York	1.2171
8	Charlotte, North Carolina	0.6281
9	Chicago, Illinois	1.2209
10	Cincinnati, Ohio	1.0415
11	Cleveland, Ohio	1.0744
12	Dallas, Texas	0.7934
13	Davenport, Iowa	0.8336
14	Denver, Colorado	0.8843
15	Des Moines, Iowa	0.8371
16	Detroit, Michigan	1.0415
17	Duluth, Minnesota	1.2468
18	Houston, Texas	0.8678
19	Indianapolis, Indiana	1.1411
20	Johnstown, Pennsylvania	0.9703
21	Kansas City, Missouri	1.0000
22	Lafayette, Indiana	1.1148
23	Lansing, Michigan	1.0577
24	Los Angeles, California	1.0578
25	Miami, Florida	0.8843
26	Milwaukee, Wisconsin	1.0415
27	Minneapolis, Minnesota	1.0415
28	New Orleans, Louisiana	0.9256
29	New York, New York	1.4322
30	Philadelphia, Pennsylvania	1.1818
31	Pittsburgh, Pennsylvania	1.0413
32	Portland, Maine	1.1226
33	Providence, Rhode Island	1.1209
34	St. Louis, Missouri	1.1009
35	San Diego, California	1.0768

TABLE 7.1 - CONCLUDED

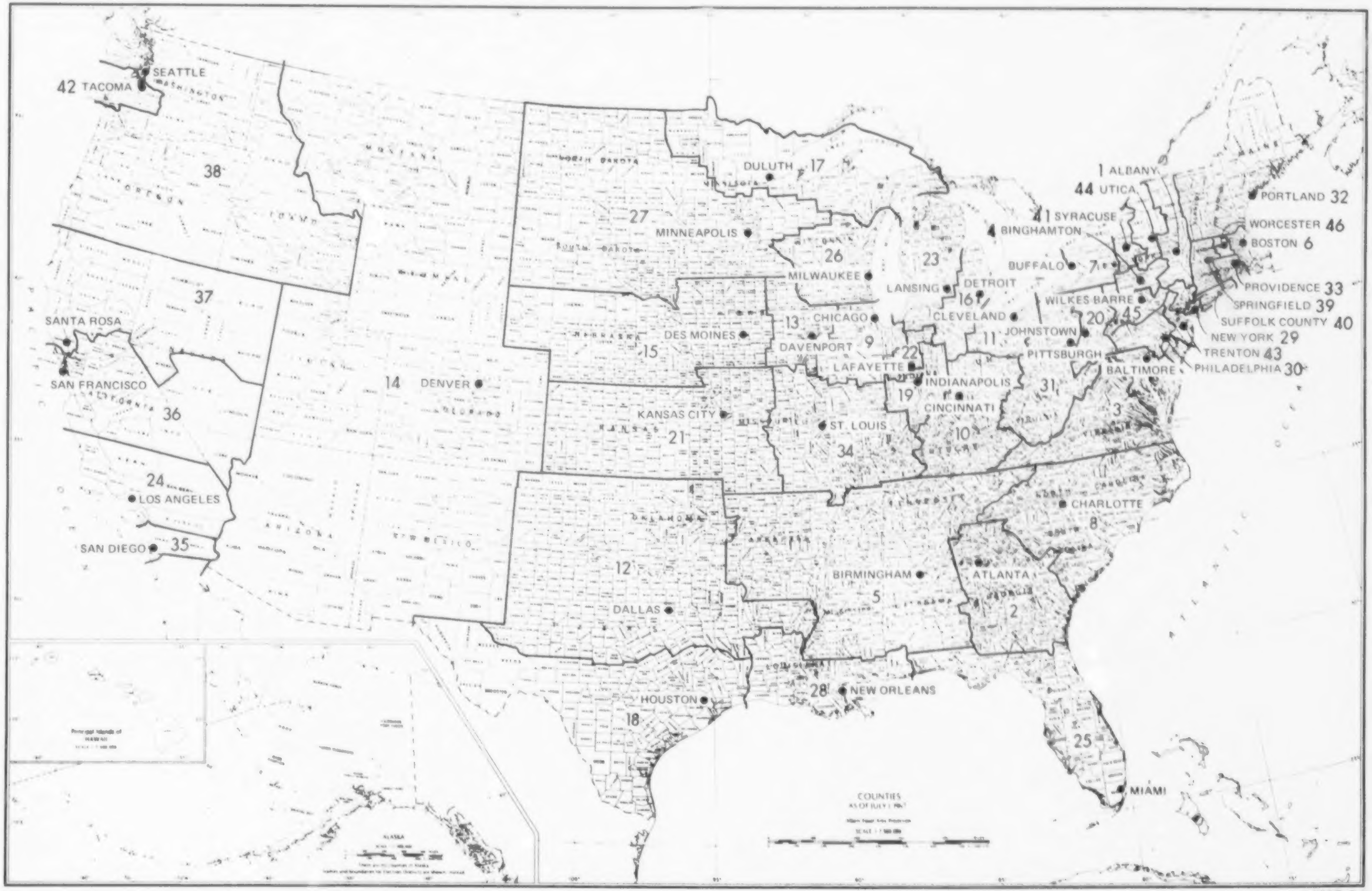
City Code (From Map No. 1)	City	Multiplier
36	San Francisco, California	1.3175
37	Santa Rosa, California	1.0855
38	Seattle, Washington	1.0330
39	Springfield, Massachusetts	1.0919
40	Suffolk County, New York	1.2265
41	Syracuse, New York	1.2000
42	Tacoma, Washington	1.0862
43	Trenton, New Jersey	1.1205
44	Utica, New York	1.1902
45	Wilkes-Barre, Pennsylvania	0.9316
46	Worcester, Massachusetts	1.1055

STATE AND TERRITORIAL MULTIPLIERS

Alaska	2.7362
Hawaii	1.4086
Puerto Rico	0.9749
Trust Territories	0.8985

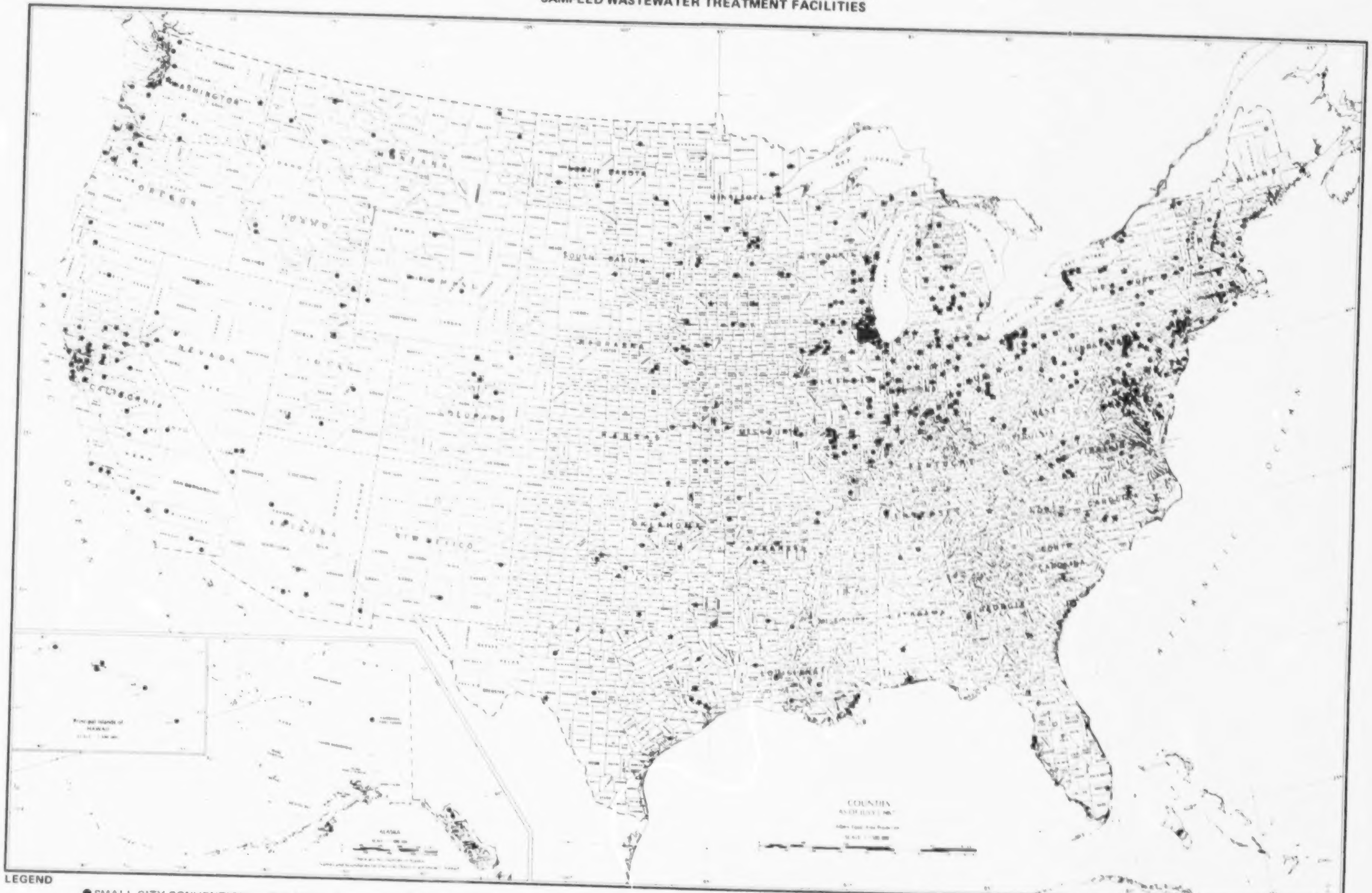
E.P.A. MUNICIPAL CONSTRUCTION COST INDEX MAP

WASTEWATER TREATMENT PLANTS - CITY MULTIPLIERS


42 TACOMA
SEATTLE
38
37
SANTA ROSA
SAN FRANCISCO
36
24
LOS ANGELES
SAN DIEGO
35
14
DENVER
DULUTH
17
27
MINNEAPOLIS
26
MILWAUKEE
23
LANSING
DETROIT
16
CLEVELAND
DES MOINES
15
13
CHICAGO
DAVENPORT
9
LAFAYETTE
22
INDIANAPOLIS
19
CINCINNATI
10
KANSAS CITY
21
ST. LOUIS
34
12
DALLAS
11
BIRMINGHAM
5
ATLANTA
2
CHARLOTTE
8
HOUSTON
18
28
NEW ORLEANS
25
MIAMI
1 ALBANY
44 UTICA
41 SYRACUSE
4 BINGHAMTON
BUFFALO
7
WILKES BARRE
20
45
JOHNSTOWN
11
PITTSBURGH
31
BALTIMORE
3
PORTLAND 32
WORCESTER 46
BOSTON 6
PROVIDENCE 33
SPRINGFIELD 39
SUFFOLK COUNTY 40
NEW YORK 29
TRENTON 43
PHILADELPHIA 30
COUNTIES
AS OF JULY 1, 1967

MAP 7.1

E.P.A. MUNICIPAL CONSTRUCTION COST STUDY
SAMPLED WASTEWATER TREATMENT FACILITIES

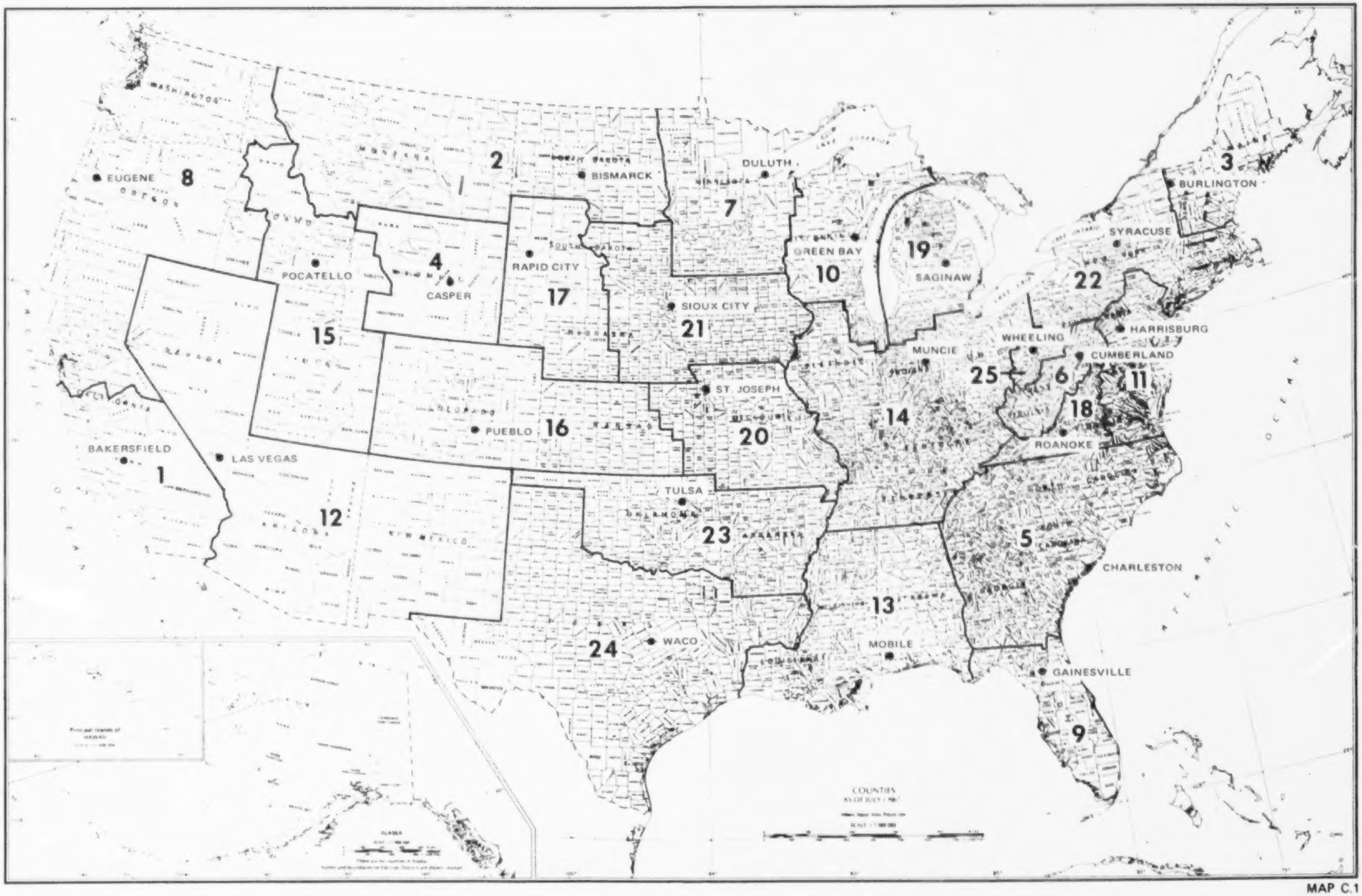

COUNTIES
ALASKA
Principal Islands of HAWAII
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
ARIZONA
COLORADO
NEW MEXICO
SOUTH DAKOTA
NORTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
ARKANSAS
KENTUCKY
TENNESSEE
GEORGIA
ATLANTIC OCEAN
PACIFIC OCEAN

LEGEND

● SMALL CITY CONVENTIONAL TREATMENT (SCCT) ★ LARGE CITY ADVANCED TREATMENT (LCAT)

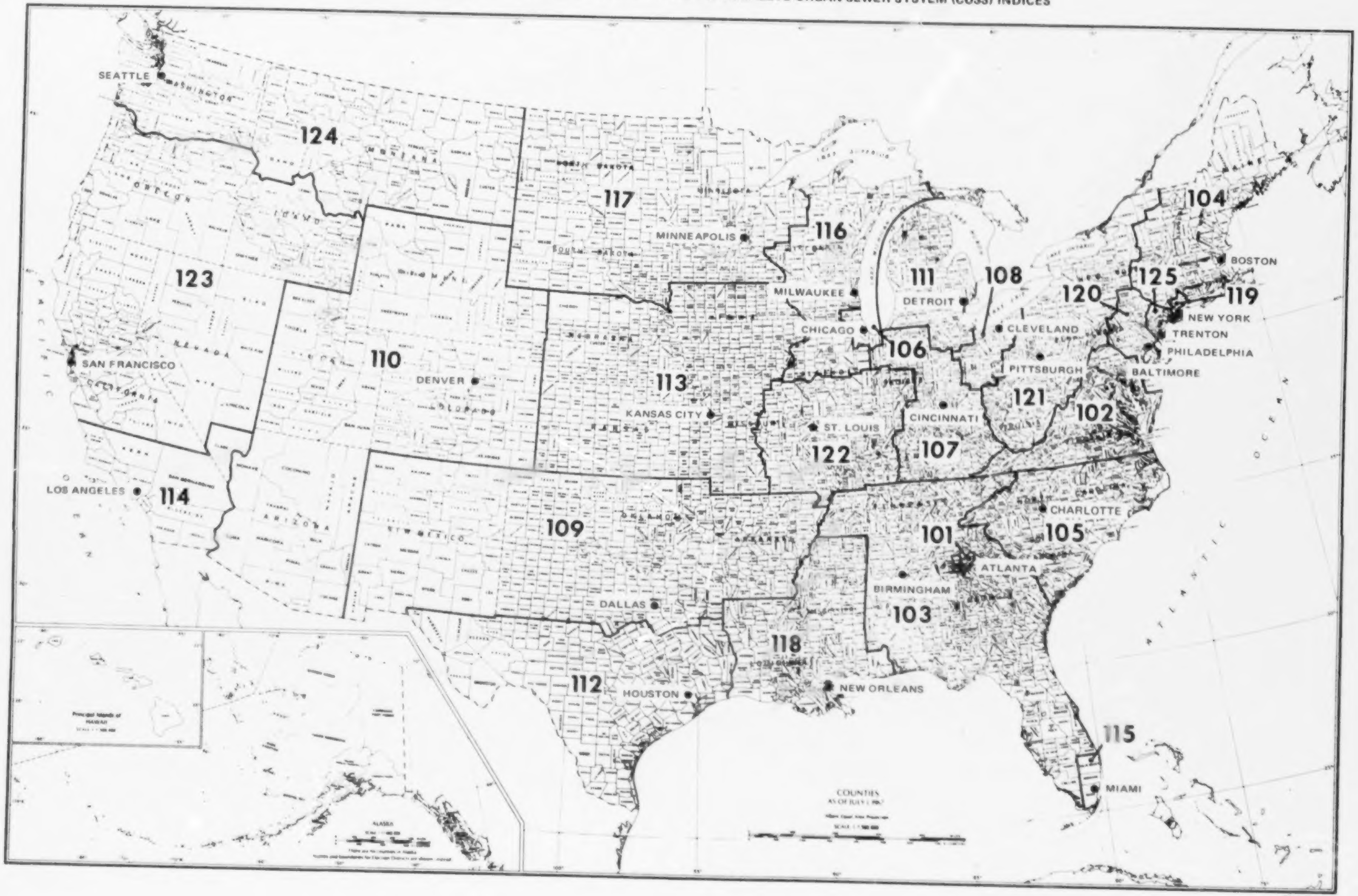
MAP B.1

E.P.A. MUNICIPAL CONSTRUCTION COST INDEX MAP
FOR SMALL CITY CONVENTIONAL TREATMENT (SCCT) PLANT INDICES


EUGENE
8
2
BISMARCK
DULUTH
7
3
BURLINGTON
POCATELLO
4
CASPER
RAPID CITY
17
SIOUX CITY
21
GREEN BAY
10
19
SAGINAW
SYRACUSE
22
HARRISBURG
15
MUNCIE
WHEELING
CUMBERLAND
25
6
11
18
ROANOKE
ST. JOSEPH
14
PUEBLO
16
20
BAKERSFIELD
LAS VEGAS
1
12
TULSA
23
5
CHARLESTON
13
24
WACO
MOBILE
GAINESVILLE
9
COUNTIES

MAP C.1

E.P.A. MUNICIPAL CONSTRUCTION COST INDEX MAP
FOR LARGE CITY ADVANCED TREATMENT (LCAT) PLANT & COMPLETE URBAN SEWER SYSTEM (CUSS) INDICES


SEATTLE
124
117
116
104
123
MINNEAPOLIS
111
108
BOSTON
125
120
119
MILWAUKEE
DETROIT
NEW YORK
CHICAGO
CLEVELAND
TRENTON
106
PHILADELPHIA
110
SAN FRANCISCO
PITTSBURGH
BALTIMORE
DENVER
113
121
102
KANSAS CITY
CINCINNATI
ST. LOUIS
122
107
LOS ANGELES
114
CHARLOTTE
109
101
105
ATLANTA
BIRMINGHAM
DALLAS
103
118
112
HOUSTON
NEW ORLEANS
115
MIAMI
PACIFIC
ATLANTIC
OCEAN
COUNTIES

MAP C.2

APPENDIX A

METHODOLOGY

APPENDIX A

METHODOLOGY

A.1 General

Based on a preliminary survey of potential sources of construction bid data for wastewater treatment plants, it was determined that the EPA municipal construction grant files, located in the ten regional offices, provided the most consistent and detailed cost information. A more in-depth study of these files furnished information used to organize the data collection effort and develop the data worksheet shown as Figure A.1.

Basically, this worksheet is arranged to allow tabulation of general facility information and the three orders of cost data as shown in the left margin of Figure A.1 and as defined in Section 5.2. A separate worksheet was completed for each facility sampled. The completed worksheets were sent to a central location for quality assurance and keypunching into the data base.

A.2 Worksheet Definitions

The following is a block by block description of the data fields provided on the wastewater treatment plant worksheet, Figure A.1. To facilitate data collection, many fields utilize coded items as shown on Table A.1. This table should be used in conjunction with Figure A.1 and the following field descriptions:

(1) Grant No. - This six-digit number indicates the particular grant under which EPA funds are allotted for treatment facilities. A grant may apply to both sewer and treatment needs; however, only treatment costs were collected on this worksheet.

(2) Facility Name - This is the commonly accepted title of the treatment plant being constructed.

(3) City or Town - Indicated here is the name of the city in which the facility is located.

(4) State - Shown is the state in which the facility is located.

(5) County - This is the county in which the facility is located.

(6) Region - Coded here is the number of the EPA Region in which the facility is located.

(7) A/F Number - The Authority/Facility Number is a nine-digit number indicating the state, in the first two digits, authority, in the next four digits and the facility within that authority in the last three digits. This number uniquely identifies the particular facility and can be used to identify the facility's discharge permit number and grant number through the EPA's cross reference index.

(8) Type Facility - This block refers to the type of construction provided for in the grant number specified. Treatment facilities only, collection facilities only, or a combination of both may be coded, as indicated on the code reference table included as Table A.1.

(9) Change - Table A.1 lists the possible change codes each specifying a purpose for the treatment facility construction.

(10) Present MGD - This field allows input of the design flow of the treatment plant prior to construction. For new facilities, this field is left blank.

(11) Level of Treatment - Input here is the appropriate code from Table A.1 indicating the degree of treatment attained before construction.

(12) Projected MGD - This field refers to the design flow of the plant after construction.

(13) Level of Treatment - This field utilizes Table A.1 and specifies the design level of treatment after construction.

(14) Outfall - Referred to in this field is the method of disposal of liquid effluent as coded on Table A.1.

(15) Acres - In cases where land was acquired for the construction of new wastewater treatment facilities, the number of acres is specified in this field.

(16) Topography - This field employs the codes listed in Table A.1 and classifies the type of terrain on which construction was performed.

(17) Soil Type - As listed in Table A.1, this field employs a two digit code. The first digit categorizes the groundwater level with respect to foundation construction. The second digit specifies the soil type at the construction site.

(18) Use - This field utilizes a two-digit code to specify both the land use designation applicable to the construction site and the surface geography of the site.

(19) Extra Conditions - Extraordinary site conditions which significantly affected construction are coded numerically in this field and explained under the same code in the "comments" section of the worksheet.

(20) Population - Based on the breakdown listed in Table A.1, the population of the community served by the treatment facility is coded in this block. This population is not necessarily the service population of the plant.

(21) Distance - Coded in this field is the distance, in tens of miles, from the treatment plant to the closest city of 50,000 population or more.

(21a) Zip Code - This field provides the zip code of the city or town specified in Block 3.

(22) Total Project Cost - Input here is the total eligible project cost as determined from the EPA Step III grant file for the facility. The EPA share will generally be 75 percent of this number. If code 03 is used in Block 8, the cost in Block 22 will include the cost for the wastewater collection system.

(23) Date - This is the contract date as specified in the Step III, construction contract documents for the project cost shown in Block 22.

(24) Step I Cost - Input in this field is the total grant eligible cost for the Step I planning phase. If the project included collection works in addition to treatment facilities, the Step I cost indicated will include facilities planning costs for both.

(25) Date - This field was provided for the grant award date for the Step I planning cost.

(26) Step II Cost - Input here is the total grant eligible cost for the Step II design phase. Again, if the project included collection facilities in addition to treatment works, the cost for design of both would be included in Block 26.

(27) Date - This block indicates the grant award date for the Step II phase.

(28) Construction Cost - This field specifies the actual construction cost obtained from the project contract documents. This cost includes total, eligible capital construction expenses and does not include Step I or Step II costs or Step III non-construction costs. For projects covering both collection and treatment facilities, only the construction bid cost for the treatment works is indicated in Block 28.

(29a-h) Non-Construction Cost - These eight blocks are allocated for Step III non-construction cost items as enumerated in Table A.1, Items 30a&b. Blocks 30a through h correspond to the same lettered cost, i.e. Block 30c is the appropriate code for the cost tabulated in Block 29c. The non-construction item costs were obtained directly from the EPA grant files.

(29i) Architect/Engineer - The name of the engineering firm responsible for the design and construction of the treatment plant was coded in this space.

(29j) Contractor - The name of the construction company to which the treatment plant contract was awarded was coded in this space.

(30a-h) Non-construction Cost Code - These blocks correspond to the non-construction item blocks (Block 29) with the same letter code. The codes utilized for specifying non-construction item costs are listed in Table A.1.

(31) Cost Category - As indicated in Table A.1, three single letter codes may be used in this block:

L - This indicates that the cost in Block 34 represents a lump sum cost for the plant construction component coded in Block 33. Plant construction components are items such as equipment or electrical work which are bid as a total cost for the entire plant and are not broken down by unit process.

P - Use of this code indicates that the cost tabulated in Block 34 applies to the unit process specified in Block 32. In many instances, unit processes were constructed but the total cost was unavailable. In these cases, the process was indicated with a P-code in Block 31 with the Block 34 cost left blank.

C - This code in Block 31 means that the cost shown in Block 34 is the total cost of a particular construction component for the unit process indicated in Block 32. For example, a C-code would be used when a cost for the equipment for a secondary clarifier was available.

Note: Section 6.4 describes in more detail the use of these cost categories.

(32) Unit Process - When a "P" or "C" is indicated in Block 31, the unit process to which the cost applies is coded in this field based on the Table A.1 codes. The unit process field is left blank when a plant construction component cost is indicated, i.e. Block 31 - "L".

(33) Change/Component - The codes used in this field depend on the cost category shown in Block 31. If Block 31 is:

L - The plant construction component code from Table A.1 is coded in Block 33.

P - The nature of change (as used also for Block 9) is coded in Block 33. This refers to the construction plans for the specific unit process indicated in Block 32.

C - The unit process construction component code (same as plant construction component codes) from Table A.1 is shown in this field.

(34) Total Cost - This field contains the total construction cost for the item specified in Blocks 31, 32 and 33. Thus, for a new, primary sedimentation unit process Block 31 shows "P", Block 32 shows "03" and Block 33 shows "04" with the cost indicated in Block 34.

(35) Unit Cost - When the construction bid data contained total cost broken down into units and unit cost, Block 35 was employed to tabulate the unit cost. For example, concrete for primary sedimentation basins may have been broken down in the bid documents by cubic yard and cost per cubic yard. If so, Blocks 35 and 36 indicated these figures.

(36) Units - This field specifies, when available, the units of a certain construction component. See the Block 35 description above.

(37) Special Condition - When extraordinary conditions existed which affected the costs presented in Blocks 34 and 35, a numeric code was employed in this field. The specific conditions where then enumerated in the "Comments" section of the form under the same code number.

(38) Confidence - For some projects, costs were available for final, in-place construction costs including increases or decreases in bid cost due to valid change orders accepted during construction. Costs shown in Blocks 34 and 35 were identified as final costs using the confidence codes shown in Table A.1.

Comments Section - This section of the data worksheet allowed explanations for special conditions identified in Blocks 19 and 37. In addition, when codes indicated unidentifiable or uncoded items, such as Code 09 for Block 14 or Code 42 for Block 32, a description of such items was documented in the Comments Section.

A.3 Comments on the Use of Certain Data

A.3.1. Variation in Constructiuon Costs Due to Site Conditions

It was anticipated that variation in construction costs for similar unit processes or plants might be correlated with specific geographic or geologic factors such as topography, land use or soil type. With this intention, Blocks 16 through 21 were inserted on the worksheet. However, after analysis of several possible relationships, it was concluded that such correlations, if existent, were not quantifiable using data collected for this study. There may be many reasons for this inability to relate these variables. It is possible that increased costs directly attributable to soil type or land use may be such a low percentage of construction cost that they are obscured by the larger variations in cost due to such factors as differences in design standards and preferences for the same size unit process from engineer to engineer. Furthermore, fluctuation in construction material markets for steel or concrete may also overshadow lesser cost differentials due to site conditions.

A.3.2 Step I and Step II Costs

In order to develop valid Step I and Step II cost percentages of construction cost as shown in Table 6.3, it was necessary to isolate and analyze projects for treatment plants only. Step I and Step II costs for projects with sewers as well as plants were not applicable to construction estimates for plants only.

TABLE A.1

CODE REFERENCE TABLE

SEWAGE TREATMENT PLANTS

ITEM 8 - TYPE FACILITY

01 - Treatment Plant
02 - Collection System
03 - Both 01 and 02

ITEMS 9, 33 - NATURE OF CHANGE

01 - Enlarge
02 - Upgrade
03 - Enlarge and Upgrade
04 - New Construction
05 - Replace
06 - Abandon
07 - No Change
08 - Modification
09 - Other

ITEM 11 - LEVEL OF TREATMENT

00 - Raw Discharge
01 - Primary (BOD/SS eff 50/50)
02 - Advanced Primary (BOD/SS eff 50/50-30/30)
03 - Secondary (BOD/SS eff 30/30-25/25)
04 - Greater than Secondary
05 - Nutrient Removal
06 - Secondary Treatment with Nutrient Removal
07 - Greater than Secondary with Nutrient Removal
08 - Zero Discharge
09 - No Collection
99 - No Information

ITEM 14 - DISPOSAL OF EFFLUENT (OUTFALL)

01 - Outfall to Surface Waters
02 - Ocean Outfall
03 - Holding Pond
04 - Deep Well
05 - Ground Water Recharge
06 - Other Land Disposal
07 - Recycling and Reuse
08 - Septic Tank Field
09 - Other

ITEM 16 - TOPOGRAPHY

01 - Flat
02 - Rolling
03 - Hilly
04 - Steep

ITEM 17 - SOIL TYPE

1st Digit
- 00 - No Ground Water Problem
- 10 - Excavation into Ground Water
- 20 - Surface Saturation
- 30 - Ground Water Unknown

2nd Digit
- 01 - Soft Fines
- 02 - Medium Fines
- 03 - Stiff Fines
- 04 - Coarse
- 05 - Rock

ITEM 18 - LAND USE

1st Digit
- 10 - Agricultural
- 20 - Residential
- 30 - Dense Residential
- 40 - Commercial
- 50 - Dense Commercial
- 60 - Industrial
- 70 - Dense Industrial
- 80 - Municipal Site

2nd Digit
- 01 - Open /Vacant
- 02 - Forested/Brushy
- 03 - Structures
- 04 - Existing Thoroughfare

ITEM 20 - POPULATION

01 - Less than 2,500
02 - 2,500-5,000
03 - 5,000-10,000
04 - 10,000-25,000
05 - 25,000-50,000
06 - 50,000-100,000
07 - 100,000-250,000
08 - 250,000-500,000
09 - 500,000-1,000,000
10 - Greater than 1,000,000

ITEMS 30a-h - NONCONSTRUCTION COST

01 - Administrative/Legal
02 - Preliminary
03 - Land, Structures, Right-of-way
04 - Architectural Engineering Basic Fees
05 - Other Architectural Engineering Fees
06 - Project Inspection Fees
07 - Land Development
08 - Relocation Expenses
09 - Relocation Payments to Individuals and Businesses
10 - Demolition and Removal
11 - Bond Interest
12 - Contingency
13 - Indirect Costs
14 - Miscellaneous
15 - Other Significant Ineligible Costs
15 - Equipment
17 - Other Eligible Costs (Comment)

ITEM 31 - COST CATEGORY

L - Lump Sum Cost
P - Unit Process Code
C - Cost Element

ITEM 33 - L & C ITEMS

00 - Material
01 - Labor
02 - In Place
10 - Mobilization (L.S.)
20 - Sitework, Incl. Excavation
23 - Sitework w/o Excavation
24 - Excavation (Yd^3)
25 - Pilings, Spec. Found. Dewatering
30 - Electrical (L.S.)
33 - Controls & Instr.
40 - Piping (All)
43 - Yard Piping
44 - Process Piping
50 - Equipment (L.S.)
60 - Concrete (Yd^3)
70 - Steel (Tons)
80 - HVAC
90 - Miscellaneous

ITEM 32 - UNIT PROCESSES

01 - Preliminary Treatment
02 - Pumping
03 - Sedimentation, Primary
04 - Trickling Filter(Without
05 - Activated Sludge(Clarification
06 - Filtration
07 - Activated Carbon
08 - Chemical Addition
09 - Biological Nitrification
10 - Biological Denitrification
11 - Ion Exchange
12 - Breakpoint Chlorination
13 - Ammonia Stripping
14 - Chlorination
15 - Ozonation
16 - Other Disinfection
17 - Biofilter
18 - Land Treatment of Effluent
19 - Oxidation Ponds
20 - Aerated Lagoons
21 - Aerobic Digestion
22 - Anaerobic Digestion
23 - Sludge Lagoons
24 - Heat Treatment
25 - Air Drying
26 - Mechanical Dewatering
27 - Gravity Thickening
28 - Incineration
29 - Landfill
30 - Land Spreading of Sludge
31 - Ocean Dumping
32 - Other Sludge Handling
33 - Effluent Outfall
34 - Outfall Pumping
35 - Outfall Diffuser
36 - Clarification
37 - Bio-Disc
38 - Control/Lab/Maint. Buildings
39 - Flotation Thickener
40 - Flow Equalization Reservoir
41 - O_2 Activated Sludge
42 - Other treatment
43 - Post-Aeration

ITEM 38 - CONFIDENCE IN UNIT PROCESS COST

01 - Bid Data
02 - Final Construction Cost Data

DATA COLLECTOR ______________________
DATE OF COLLECTION ______________________
DATA LOCATION ______________________

WASTE WATER TREATMENT PLANTS

GENERAL

(1) GRANT NO. (2) FACILITY NAME (3) CITY OR TOWN (4) STATE (5) COUNTY

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

I 1

(6) EPA REGION (7) A/F NUMBER (8) TYPE FAC (9) CHANGE (10) PRESENT MGD (11) LEVEL OR TRTMT (12) PROJECTED MGD (13) LEVEL OR TREAT (14) OUTFALL (15) ACRES (16) TOPO (17) SOIL (18) USE (19) X COND (20) POP (21) DIST (21a) ZIP

I 2 . .

(22) TOTAL PROJECT COST (23) DATE (24) STEP 1 COST (25) DATE (26) STEP 2 COST (27) DATE

I 3

1ST ORDER

(28) CONSTRUCTION (29a) NON CONSTRUCTION (30a) CODE (29b) NON CONS ITEM (30b) CODE (29c) NON CONS ITEM (30c) CODE (29d) NON CONS ITEM (30d) CODE (29e) NON CONS ITEM (30e) CODE

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(29f) NON CONS ITEM (30f) CODE (29g) NON CONS ITEM (30g) CODE (29h) NON CONS ITEM (30h) CODE (29i) A F (29j) CONT

2ND & 3RD ORDER

(31) COST CAT (32) PROCESS (33) CHNG/ COMP (34) TOTAL COST ($) (35) UNIT COST (36) UNITS (37) SPEC COND (38) CONF | (31) COST CAT (32) PROCESS (33) CHNG COMP (34) TOTAL COST ($) (35) UNIT COST (36) UNITS (37) SPEC COND (38) CONF

COMMENTS

COMMENT SECTION

A12

FIGURE A.1

APPENDIX B

DESCRIPTION OF DATA BASE

APPENDIX B

DESCRIPTION OF DATA BASE

Data for this study were collected from 536 Federally funded facilities spread over the ten EPA regions. Name, grant number, and other information for each sample facility are listed in Table B.1, and Map B.1 shows their locations on the National Map.

In order to display more clearly the types of plants studied, four charts are included in this section showing the number of data points included in certain categories. The codes used in these tables for various parameters such as level of treatment, projected change and unit process are defined in Appendix A. Table B.2 shows a breakdown by region and by state of the data base by plant design flow and level of treatment. Table B.3 shows how the sample divided between facilities in Standard Metropolitan Statistical Areas (SMSA's) and those outside such areas and breaks down the sample by the type of land use prevalent at the site before construction began. Within the data base, some sample facilities were being funded for upgrading, enlargement, or both, while some were entirely new. Table B.4 shows how many sample plants fall in each category. Similarly, the data base includes plants employing various treatment processes, as shown in Table B.5.

TABLE B.1

LISTING OF WASTE WATER TREATMENT PLANTS SAMPLE

GRANT NO.	FACILITY NAME	PROJ. FLOW	LEVEL OF TREAT.	STATE	COUNTY	INDEX CITY	LCAT/SCCT
010250	MONROEVILLE-DOUBLE BRANCH	1.00	07	ALABAMA	MONROE	103	4
010256	NEW HOPE	.25	03	ALABAMA	MADISON	013	1
010296	TOWN CREEK SEWER SYSTEM	.15	03	ALABAMA	LAWRENCE	013	1
020039	FAIRBANKS WWTP	8.00	03	ALASKA	NORTH STAR	026	1
020043	HAINES STP & COLL	.30	03	ALASKA	HAINES	026	1
020046	SKAGWAY STP & COLLECTION	.30	03	ALASKA	SKAGWAY	026	1
020047	PETERSBURG WWTP	.80	03	ALASKA	WRANGELL	026	1
020074	KODIAK SYSTEM	2.13	03	ALASKA	KOKIAK IS	026	1
040134	RANDOLPH PARK STP	1.50	04	ARIZONA	PIMA	110	4
040138	IRON SPRINGS WWTF #B	.10	03	ARIZONA	YAVAPAI	012	1
040138	IRON SPRINGS WWTF #A	.03	03	ARIZONA	YAVAPAI	012	1
040140	LAKE HAVASU STP	.20	03	ARIZONA	MOHAVE	012	1
040141	CASA GRANDE STP	3.00	03	ARIZONA	PINAL	012	1
040151	INA ROAD STP	25.00	03	ARIZONA	PIMA	012	2
050305	HOT SPRINGS REGIONAL WWTP	12.00	07	ARKANSAS	GARLAND	109	3
050339	SPRINGDALE WWTP	16.00	03	ARKANSAS	WASHINGTON	023	2
050346	PARAGOULD WWTP	2.20	03	ARKANSAS	GREENE	023	1
050350	GREENBRIER WWTP	.12	07	ARKANSAS	FAULKNER	109	4
050367	WEST SIDE WWTRT WORKS	3.00	04	ARKANSAS	CRAIGHEAD	109	4
060669	TERMINAL ISLAND STP	30.00	03	CALIFORNIA	LOS ANGELES	001	2
060696	CENTRAL CONTRA COSTA STP	30.00	07	CALIFORNIA	CONTRA COSTA	123	3
060731	AVALON STP	1.00	03	CALIFORNIA	LOS ANGELES	001	1
060763	KERMAN WWTP	.41	03	CALIFORNIA	FRESNO	001	1
060767	MAIN WQCF	67.00	04	CALIFORNIA	SAN JOAQUIN	123	3
060771	PALM DESERT WRP	2.10	03	CALIFORNIA	RIVERSIDE	001	1
060772	SCOTTS VALLEY STP	.40	03	CALIFORNIA	SANTA CRUZ	001	1
060775	VISALIA WCP	8.30	03	CALIFORNIA	TULARE	001	1
060778	ANGELS CAMP STP	.32	03	CALIFORNIA	CALAVERAS	008	1
060779	ORANGE CO. WWRP #1	46.00	03	CALIFORNIA	ORANGE	001	2
060786	BOLINAS STP	.07	03	CALIFORNIA	MARIN	008	1
060787	LIVERMORE	6.00	07	CALIFORNIA	ALAMEDA	123	4
060790	LAGUNA WWTP	15.00	03	CALIFORNIA	SONOMA	123	3
060796	ROSEVILLE WWTF	5.75	04	CALIFORNIA	PLACER	123	4
060797	SANTA BARBARA STP	11.00	03	CALIFORNIA	SANTA BARBARA	001	2
060800	BASS LAKE STP	.50	03	CALIFORNIA	MADERA	001	1
060801	CALEXICO STP	2.20	03	CALIFORNIA	IMPERIAL	001	1
060804	CENTRAL CONTRA COSTA STP	30.00	04	CALIFORNIA	CONTRA COSTA	123	3
060810	FAIRFIELD-SUISUN WWTF	10.35	04	CALIFORNIA	SOLANO	123	3
060813	INYO CA WWTF	.85	03	CALIFORNIA	INYO	001	1
060816	NORTHWEST CLEAR LAKE REG.	2.45	03	CALIFORNIA	LAKE	008	1
060818	LOMPOC REGIONAL WWTF	5.00	04	CALIFORNIA	SANTA BARBARA	114	4
060823	MT. SHASTA WPCF	.70	03	CALIFORNIA	SISKIYOU	008	1
060833	SOLVANG STP	.54	03	CALIFORNIA	SANTA BARBARA	001	1
060835	TULARE TREATMENT PLANT	4.50	03	CALIFORNIA	TULARE	001	1
060837	VALLEJO STP	13.00	04	CALIFORNIA	SOLANO	123	3
060840	SOUTH WWTF	7.00	03	CALIFORNIA	SUTTER/YUBA	008	1
060882	IMPERIAL STP	.70	03	CALIFORNIA	IMPERIAL	001	1
060897	TERMINAL ISLAND	30.00	03	CALIFORNIA	LOS ANGELES	001	2
060913	MODESTO STP	45.00	02	CALIFORNIA	STANISLAUS	008	2
060915	NAPA VALLEY-AMERICAN CANY	15.00	04	CALIFORNIA	NAPA	123	3
060925	PACIFICA WPCF	4.30	03	CALIFORNIA	SAN MATEO	008	1
060938	SACRAMENTO REGIONAL WWTF	136.00	07	CALIFORNIA	SACRAMENTO	123	3
060947	SAN JOSE/SANTA CLARA WPCF	143.00	07	CALIFORNIA	SANTA CLARA	123	3

060950	SAN MATEO SUBREGIONAL STP	13.60	04	CALIFORNIA	SAN MATEO	123	3
060956	SHASTA DAM AREA STP	.50	02	CALIFORNIA	SHASTA	008	1
060964	TRACY WWTF	5.50	03	CALIFORNIA	SAN JOAQUIN	008	1
060967	SONORA STP	2.60	03	CALIFORNIA	TUOLUMNE	008	1
061081	HANGTOWN CREEK WWTP	1.60	04	CALIFORNIA	EL DORADO	123	4
061121	TAHOE-TRUCKEE STP	4.83	07	CALIFORNIA	NEVADA	123	4
061131	WILLITS WQCP	.64	03	CALIFORNIA	MENDOCINO	008	1
080322	UPPER THOMPSON WWTP	1.50	07	COLORADO	LARIMER	110	4
080329	LITTLETON-ENGLEWOOD WWTP	20.00	03	COLORADO	ARAPAHOE	016	2
080330	W. JEFFERSON COUNTY WWTP	.50	04	COLORADO	JEFFERSON	110	4
080352	LONGMONT WWTP & SEWER SYS	8.20	06	COLORADO	BOULDER	110	4
080354	EATON WWTP	.34	03	COLORADO	WELD	016	1
080357	LYONS WWTP	.29	03	COLORADO	BOULDER	016	1
090153	KILLINGLY WWTP	8.00	03	CONNECTICUT	WINDHAM	022	1
090155	PAWCATUCK WPCF	1.31	03	CONNECTICUTT	NEW LONDON	022	1
090155	STONINGTON WPCF	.66	03	CONNECTICUTT	NEW LONDON	022	1
090175	NEW LONDON WPCF	10.00	03	CONNECTICUT	NEW LONDON	022	2
100061	DELAWARE CITY WWTP	.50	04	DELAWARE	NEWCASTLE	120	4
100088	S. COASTAL REGIONAL STP	3.00	04	DELAWARE	SUSSEX	120	4
120428	PENSACOLA WTW	20.00	07	FLORIDA	ESCAMBIA	103	3
120433	SOUTH CROSS BAYOU WTW	27.00	06	FLORIDA	PINELLAS	103	3
120474	FORT LAUDERDALE STP	22.00	06	FLORIDA	BROWARD	115	3
120523	NW STP & EFFLUENT DISPOSA	16.00	04	FLORIDA	PINELLAS	103	3
130315	RICHMOND HILL SEWERAGE SY	.50	03	GEORGIA	BRYAN	005	1
130357	ALMA	.75	04	GEORGIA	BACON	103	4
150046	SAND ISLAND STP PHASE I	85.00	01	HAWAII	HONOLULU	027	2
150050	HANAPEPE-ELEELE WWTF	.40	03	HAWAII	KAUAI	027	1
150051	HONOULIULI STP PHASE I	25.00	01	HAWAII	HONOLULU	027	2
150054	LAHAINA STP	3.20	03	HAWAII	MAUI	027	1
150057	KULAIMANO STP	.50	03	HAWAII	HAWAII	027	1
160144	PARIS SEWEPAGE	.10	08	IDAHO	BEAR LAKE	015	1
160185	SOUTH FORK COEUR D'AIENE	.13	03	IDAHO	SHOSHONE	008	1
160188	POCATELLO STP	7.50	03	IDAHO	BANNOCK	015	1
160194	WEST BOISE (GARDEN CITY)	5.00	03	IDAHO	ADA	008	1
160204	CULDESAC WWTP	.05	03	IDAHO	NEZ PERCE	008	1
160208	GOWEN FIELD WWTP	.26	08	IDAHO	ADA	008	1
170484	LAKE VILLA	.30	07	ILLINOIS	LAKE	106	4
170508	BUSHNELL STP	.70	04	ILLINOIS	MCDONOUGH	116	4
170561	RIDGEWAY	.14	04	ILLINOIS	GALLATIN	122	4
170660	RICHMOND	.38	06	ILLINOIS	MCHENRY	106	4
170680	SPARTA	.65	04	ILLINOIS	RANDOLPH	122	4
170749	TAYLORVILLE SANITARY DIST	1.92	04	ILLINOIS	CHRISTIAN	122	4
170759	MARSEILLES	1.23	04	ILLINOIS	LASALLE	116	4
170766	MT CARMEL WWTP	2.00	04	ILLINOIS	WABASH	122	4
170865	MOMENCE	1.60	04	ILLINOIS	KANKANEE	116	4
170876	ALGONQUIN	1.25	07	ILLINOIS	MCHENRY	106	4
170924	SALEM	1.00	04	ILLINOIS	MARION	122	4
170930	OLMSTED	.07	03	ILLINOIS	PULASKI	014	1
170951	TROY	1.00	07	ILLINOIS	MADISON	122	4
170956	STOCKTON	.30	04	ILLINOIS	JO DAVIES	116	4
170970	O'FALLON	3.00	03	ILLINOIS	ST. CLAIR	014	2
170973	DOWNERS GROVE SANITARY D.	9.60	07	ILLINOIS	DUPAGE	106	4
170979	LENA	.30	03	ILLINOIS	STEPHENSON	014	1
170992	GRAYVILLE	.30	03	ILLINOIS	WHITE	014	1
171001	GALVA	.42	07	ILLINOIS	HENRY	116	4
171001	GALVA	.41	06	ILLINOIS	HENRY	116	4
171006	BLOOMINGTON-NORMAL STP	16.00	07	ILLINOIS	MCLEAN	116	3
171023	BELLEVILLE STP NO. 1	8.00	04	ILLINOIS	ST. CLAIR	122	4
171023	BELLEVILLE STP NO. 2	.45	04	ILLINOIS	ST. CLAIR	122	4
171060	GALENA	.50	03	ILLINOIS	JO DAVIESS	014	1

171061	COWDEN	.08	02	ILLINOIS	SHELBY	014	1
171084	NEOGA	.22	04	ILLINOIS	CUMBERLAND	014	1
171089	GIBSON CITY WWTP	.58	04	ILLINOIS	FORD	116	4
171105	BARTLETT	1.54	04	ILLINOIS	DUPAGE	106	4
171118	MOLINE	5.50	04	ILLINOIS	ROCK ISLAND	116	4
171172	ELGIN	17.00	07	ILLINOIS	KANE	106	3
171182	ALTON	10.50	03	ILLINOIS	MADISON	014	2
171196	DUQUOIN	1.20	04	ILLINOIS	PERRY	122	4
171202	MATOON	4.50	07	ILLINOIS	COLES	122	4
171215	GRANITE CITY STP	23.00	03	ILLINOIS	MADISON	014	2
171218	BENSENVILLE	4.00	04	ILLINOIS	DUPAGE	106	4
171226	STILLMAN VALLEY STP	.20	03	ILLINOIS	OGLE	014	1
171279	CENTRALIA	3.00	04	ILLINOIS	MARION	122	4
171294	WOODRIDGE WWTP	4.00	07	ILLINOIS	DUPAGE	106	4
171294	WOODRIDGE PLANT	4.00	04	ILLINOIS	DE PAGE	106	4
171310	MT VERNON STP	3.80	07	ILLINOIS	JEFFERSON	122	4
171332	EAST MOLINE	11.10	04	ILLINOIS	ROCK ISLAND	116	3
171341	FULTON	.47	03	ILLINOIS	WHITESIDE	014	1
171365	ARTHUR	.50	07	ILLINOIS	DOUGLAS	122	4
171397	HINSDALE SD STP	12.00	04	ILLINOIS	DUPAGE	106	3
171399	SALT CREEK SANITARY DIST.	5.00	07	ILLINOIS	DUPAGE	106	4
171412	CARPENTERSVILLE WWTP	5.00	06	ILLINOIS	KANE	106	4
171420	BLOOM TOWNSHIP STP	12.10	07	ILLINOIS	COOK	106	3
171436	ROCKFORD SD STP	60.20	03	ILLINOIS	WINNEBAGO	014	2
171471	DANVILLE SANITARY DISTRIC	16.00	07	ILLINOIS	VERMILLION	122	3
171584	LIBERTYVILLE WWTP	4.00	04	ILLINOIS	LAKE	106	4
171639	LAKE CO DPW-GRANDWOOD PK	.50	07	ILLINOIS	LAKE	106	4
171714	DEERFIELD WWTP	3.00	07	ILLINOIS	LAKE	106	4
171840	WHEATON SD STP	8.90	07	ILLINOIS	DU PAGE	106	4
175008	MSD OF CHICAGO	410.00	03	ILLINOIS	COOK	010	2
175058	MSD OF CHICAGO- CALUMET	446.00	03	ILLINOIS	COOK	010	2
175111	OHARE WATER RECLAM PLANT	72.00	07	ILLINOIS	COOK	106	3
175207	MSD OF CHICAGO-CALUMET	446.00	03	ILLINOIS	COOK	010	2
175213	MSD OF CHICAGO- CALUMET	446.00	03	ILLINOIS	COOK	010	2
175255	HANOVER PARK WRP	12.00	07	ILLINOIS	COOK	106	3
180260	NORTH WEBSTER	.28	06	INDIANA	KOSCIUSKO	107	4
180295	LOGANSPORT	9.00	03	INDIANA	CASS	014	1
180295	LOGANSPORT	9.00	03	INDIANA	CASS	014	1
180328	SHELBURN	.25	07	INDIANA	SULLIVAN	122	4
180329	LINDEN WWTP	.10	04	INDIANA	MONTGOMERY	122	4
180335	ELNORA STP	.10	04	INDIANA	DAVIESS	122	4
180346	BIRDSEYE STP	.06	03	INDIANA	DUBOIS	014	1
180354	WILLIAMSPORT STP	.22	03	INDIANA	WARREN	014	1
180375	ROME CITY LAGOONS	.45	06	INDIANA	NOBLE	107	4
180400	BROOKLYN WWTP	.24	03	INDIANA	MORGAN	014	1
180410	GREENSBURG	1.60	07	INDIANA	DECATUR	107	4
180434	CLARKS HILL WWTP	.15	04	INDIANA	TIPPECANOE	122	4
180445	CARMEL WWTP	3.00	06	INDIANA	HAMILTON	122	4
180467	SEYMOUR WWTP	4.30	06	INDIANA	JACKSON	107	4
180470	PARAGON STP	.07	04	INDIANA	MORGAN	122	4
180473	LAUREL	.15	04	INDIANA	FRANKLIN	107	4
180474	SCHERERVILLE	1.00	06	INDIANA	LAKE	106	4
180484	CLAY CITY	.12	04	INDIANA	CLAY	122	4
180488	RISING SUN WWTP	.36	03	INDIANA	OHIO	014	1
180494	COVINGTON WWTP	.35	03	INDIANA	FOUNTAIN	014	1
180495	DUGGER	.13	04	INDIANA	SULLIVAN	122	4
180499	SALEM	.90	04	INDIANA	WASHINGTON	107	4
180502	SUNMAN	.18	07	INDIANA	RIPLEY	107	4
180515	BROOKVILLE	.60	03	INDIANA	FRANKLIN	014	1
180520	NEW PROVIDENCE WWTP	.14	04	INDIANA	CLARK	107	4

180526	STAUNTON STP	.09	07	INDIANA	CLAY	122	4
180528	MARTINSVILLE WWTP	2.20	03	INDIANA	MORGAN	014	1
180532	MUNCIE WWTP	24.00	04	INDIANA	DELAWARE	107	3
180533	PRINCETON WWTP	2.00	04	INDIANA	GIBSON	122	4
180534	WESTVILLE WWTP	.35	07	INDIANA	LAPORTE	107	4
180555	PENNVILLE STP	.16	07	INDIANA	JAY	107	4
180574	BOSWELL	.13	06	INDIANA	BENTON	107	4
180576	DEMOTTE	.40	07	INDIANA	JASPER	107	4
180591	CONVERSE WWTP	.25	06	INDIANA	MIAMI	107	4
180595	FREMONT STP	.30	07	INDIANA	STEUBEN	107	4
180596	WATERLOO	.24	06	INDIANA	DEKALB	107	4
180617	HAMMOND	48.00	07	INDIANA	LAKE	106	4
180627	CROWN POINT WWTP	3.60	07	INDIANA	LAKE	106	4
180760	COLUMBUS	12.40	07	INDIANA	BARTHOLOMEW	107	3
180767	BLUFFTON STP	2.62	04	INDIANA	WELLS	107	4
190579	MASON CITY WWTP	6.50	07	IOWA	CERRO GORDO	113	4
190584	SIOUX CITY WWTP	30.00	07	IOWA	WOODBURY	113	3
190592	MUSCATINE WWTP	13.00	03	IOWA	MUSCATINE	021	2
190594	KEOKUK WWTP	5.00	04	IOWA	LEE	113	4
190605	HARLAN WWTP	.72	07	IOWA	SHELBY	113	4
190617	WOOLSTOCK SEWERS & LAGOON	.04	03	IOWA	WEBSTER	021	1
190637	SPENCER WWTP	3.70	07	IOWA	CLAY	113	4
200365	LEAVENWORTH WWTP	6.88	02	KANSAS	LEAVENWORTH	020	1
200429	ATLANTA LAGOONS	.21	03	KANSAS	COWLEY	016	1
200478	JUNCTION CITY WWTP	3.60	03	KANSAS	GEARY	020	1
200576	LA HARPE WWTP	.14	04	KANSAS	ALLEN	113	4
220265	CITY OF KENNER WWTP	5.00	03	LOUISIANA	JEFFERSON	013	1
220292	JEANERETTE WWTP	1.32	03	LOUISIANA	IBERIA	013	1
220295	TOWN OF BASILE WWTP	.28	03	LOUISIANA	EVANGELINE	013	1
220305	CITY OF RUSTON WWTP	4.60	03	LOUISIANA	LINCOLN	024	1
220307	GILBERT WWTP	.10	03	LOUISIANA	FRANKLIN	024	1
220314	VILLAGE OF ROSEPINE WWTP	.15	03	LOUISIANA	VERNON	013	1
220321	TOWN OF LIVINGSTON WWTP	.30	03	LOUISIANA	LIVINGSTON	013	1
230102	FORT FAIRFIELD WWTP	.88	03	MAINE	AROOSTOOK	003	1
230114	OLD ORCHARD BEACH STP	1.50	03	MAINE	YORK	003	1
230117	SOUTH PORTLAND STP	5.50	03	MAINE	CUMBERLAND	003	1
230122	PORTLAND WD WPCF	4.54	03	MAINE	CUMBERLAND	003	1
240152	CALVERT CO SANITARY DIST	.15	03	MARYLAND	CALVERT	011	1
240180	FRIENDSVILLE STP	.10	03	MARYLAND	GARRETT	006	1
240243	ACCIDENT TOWN OF	.05	03	MARYLAND	GARRETT	006	1
240255	WILLARDS WWTF	.08	03	MARYLAND	WICOMICO	011	1
240294	BALLENGER CREEK WTW	2.00	03	MARYLAND	FREDERICK	011	1
240298	SAVAGE STP	5.00	03	MARYLAND	HOWARD	011	1
240310	BACK RIVER STP	210.00	07	MARYLAND	BALTIMORE	102	3
240311	FREEDOM DIST PROJECT	1.80	03	MARYLAND	CARROLL	011	1
240311	FREEDOM DISTRICT STP	1.80	04	MARYLAND	CARROLL	102	4
240318	CLEAR SPRING STP	.20	04	MARYLAND	WASHINGTON	102	4
240366	WESTERN BRANCH STP	30.00	07	MARYLAND	PRINCE GEORGE	102	3
240393	TYLERTOWN STP	.02	03	MARYLAND	SOMERSET	011	1
240393	EWELL RHODES POINT STP	.07	03	MARYLAND	SOMERSET	011	1
240409	COX CREEK STP	15.00	03	MARYLAND	ANNE ARUNDEL	011	2
240467	CHERRY HILL	.08	04	MARYLAND	CECIL	102	4
250253	UPPER BLACKSTONE WPCF	56.00	03	MASSACHUSETTS	WORCESTER	022	2
250255	ROCKPORT STP	.80	03	MASSACHUSETTS	ESSEX	022	1
250266	REGIONAL STP	18.10	03	MASSACHUSETTS	ESSEX	022	2
250270	ORANGE STP	1.10	03	MASSACHUSETTS	FRANKLIN	022	1
250300	HULL WWTP & SEWERS	3.07	03	MASSACHUSETTS	PLYMOUTH	022	1
262034	HARBOR SPRINGS LAGOONS	.45	03	MICHIGAN	EMMET	019	1
262041	LANSING WWTP	40.50	07	MICHIGAN	INGHAM	111	3
262053	CHATHAM WWTP	.25	08	MICHIGAN	ALGER	010	1

262073	BRONSON WWTP	.50	06	MICHIGAN	BRANCH	111	4
262076	DETROIT	999.99	06	MICHIGAN	WAYNE-MACOMB	111	3
262110	CADILLAC	2.50	07	MICHIGAN	WEXFORD	111	4
262127	FLINT WWTP	50.00	07	MICHIGAN	GENESEE	111	3
262142	GRAND LEDGE WWTP	1.50	06	MICHIGAN	EATON	111	4
262148	GRATIOT CO.-FULTON DPW	.70	08	MICHIGAN	GRATIOT	111	4
262301	CHESANING	.58	06	MICHIGAN	SAGINAW	111	4
262314	CHEBOYGAN AREA WW MANAG	2.00	06	MICHIGAN	CHEBOYGAN	111	4
262315	BERRIEN CO. DPW -NILES	11.00	04	MICHIGAN	BERRIEN	111	3
262326	IRON MOUNTAIN-KINGSFORD	3.00	06	MICHIGAN	DICKINSON	116	4
262349	DOWAGIAC WWTP	2.50	07	MICHIGAN	CASS	111	4
262353	EATON RAPIDS	1.20	06	MICHIGAN	EATON	111	4
262491	MT.CLEMENS & CLINTON AREA	4.50	03	MICHIGAN	MACOMB	019	1
262501	OWOSSO	6.00	06	MICHIGAN	SHIAWASEE	111	4
262503	BIG RAPIDS WWTP	2.40	06	MICHIGAN	MECOSTA	111	4
262522	WASHTENAW COUNTY DPW	.75	06	MICHIGAN	LIVINGSTON	111	4
262535	MASON	1.00	07	MICHIGAN	INGHAM	111	4
262541	IONIA WWTP	2.85	06	MICHIGAN	IONIA	111	4
262543	LUCE CO. DPW	1.00	07	MICHIGAN	LUCE	116	4
262640	GLADWIN	.65	06	MICHIGAN	GLADWIN	111	4
270663	MSB OF TC-PRELIMINARY TMT	345.00	03	MINNESOTA	RAMSEY	007	2
270664	PRELIMINARY TMT FACILITIE	290.00	03	MINNESOTA	RAMSEY	007	2
270665	METROPOLITAN WWT WORKS	290.00	04	MINNESOTA	RAMSEY	117	3
270720	VIRGINIA	2.00	07	MINNESOTA	ST. LOUIS	117	4
270725	TWO HARBORS WWTP	1.20	07	MINNESOTA	LAKE	117	4
270741	ROGERS	.15	03	MINNESOTA	HENNEPIN	007	1
270747	ST CLOUD	13.00	07	MINNESOTA	STEARNS	117	3
270748	WESTERN LAKE SUPERIOR SAN	43.60	07	MINNESOTA	ST LOUIS	117	3
270818	STOCKTON LAGOONS	.07	03	MINNESOTA	WINONA	007	1
270837	TAUNTON WWTP	.02	03	MINNESOTA	LYON	007	1
270838	ZIMMERMAN LAGOONS	.08	03	MINNESOTA	SHERBURNE	007	1
270844	ALEXANDRIA LAKE, ETAL.	2.55	07	MINNESOTA	DOUGLAS	117	4
270845	BREEZY POINT LAGOONS	.12	08	MINNESOTA	CROW WING	007	1
270871	FARIBAULT WWTP	3.50	03	MINNESOTA	RICE	007	1
270949	MARSHALL WWTP	4.30	04	MINNESOTA	LYON	117	4
270970	MADISON LAKE	.09	04	MINNESOTA	BLUE EARTH	117	4
276743	DOVER-EYOTA ST CHARLE STP	.80	04	MINNESOTA	WINONA	117	4
290480	ST. JOSEPH WWTP	32.85	03	MISSOURI	BUCHANAN	020	2
290524	MONETT WWTP	3.07	03	MISSOURI	BARRY	020	1
290603	NEVADA WWTP	2.11	03	MISSOURI	VERNON	020	1
290629	INDEPENDENCE (ROCK CREEK)	7.50	03	MISSOURI	JACKSON	020	1
290646	WYATT LAGOON & SEWERS	.06	03	MISSOURI	MISSISSIPPI	020	1
290674	WARRENTON WWTP	.80	06	MISSOURI	WARREN	122	4
300163	KALISPELL WWTP	2.70	04	MONTANA	FLATHEAD	124	4
300194	FLAXVILLE LAGOONS	.01	08	MONTANA	DANIELS	002	1
300197	GREAT FALLS STP	21.00	03	MONTANA	CASCADE	002	2
300199	MISSOULA STP & INT.	8.00	03	MONTANA	MISSOULA	002	1
300201	GREAT FALLS STP	21.00	03	MONTANA	CASCADE	002	2
300204	POPLAR WWTP	.60	03	MONTANA	ROOSEVELT	002	1
310398	FREMONT WWTP	10.50	03	NEBRASKA	DODGE	021	2
310407	BLAIR WWTP	2.00	03	NEBRASKA	WASHINGTON	021	1
310421	SPRINGFIELD WWTP	.22	03	NEBRASKA	SARPY	021	1
310433	YORK WWTP	2.30	06	NEBRASKA	YORK	113	4
310435	ARLINGTON WWTP	.17	03	NEBRASKA	WASHINGTON	021	1
310466	HEBRON WWTP	.25	03	NEBRASKA	THAYER	021	1
320076	YERINGTON STP	.54	08	NEVADA	LYON	012	1
320078	RENO-STEAD STP	1.00	03	NEVADA	WASHOE	012	1
320085	FALLON WWTF	.64	08	NEVADA	CHURCHILL	012	1
320086	MINDEN-GARDNERVILLE STP	1.50	03	NEVADA	DOUGLAS	012	1
320091	BEATTY STP	.10	08	NEVADA	NYE	012	1

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320097	MCDERMITT STP	.05	08	NEVADA	HUMBOLDT	012	1
320107	OVERTON STP	.18	08	NEVADA	CLARK	012	1
320108	SEARCHLIGHT STP	.03	08	NEVADA	CLARK	012	1
320111	WEST WQ CONTROL PLANT	32.00	04	NEVADA	CLARK	114	3
330093	MANCHESTER WWTP	26.00	03	NEW HAMPSHIRE	HILLSBOROUGH	003	2
330104	ALLENSTOWN STP	1.05	03	NEW HAMPSHIRE	MERRIMACK	003	1
330119	WARNER VILLAGE STP	.17	03	NEW HAMPSHIRE	MERRIMACK	003	1
330137	LISBON LAGOONS	.29	02	NEW HAMPSHIRE	GRAFTON	003	1
330203	FRANKLIN REGIONAL WWTF	11.54	06	NEW HAMPSHIRE	MERRIMACK	104	3
340299	LINDEN-ROSELLE SEWERAGE A	17.00	03	NEW JERSEY	UNION	022	2
340333	PARSIPPANY-TROY HILL STP	16.00	03	NEW JERSEY	MORRIS	022	2
340340	JOINT MFG UNION&ESSEX CO.	75.00	03	NEW JERSEY	ESSEX & UNION	022	2
340344	ATLANTIC COUNTY S.A.	40.00	03	NEW JERSEY	ATLANTIC	011	2
340350	LIVINGSTON WTW UPGRADE	3.50	03	NEW JERSEY	ESSEX	022	2
340354	PEQUANNOCK,LINCOLN PARK	7.50	07	NEW JERSEY	ESSEX	125	4
340356	OCEAN CO SEWERAGE AUTH(N)	28.00	03	NEW JERSEY	OCEAN	011	2
340358	PEMBERTON M Y A	2.50	06	NEW JERSEY	BURLINGTON	125	4
340372	OCEAN COUNTY S.A CENTRAL	24.00	03	NEW JERSEY	OCEAN	011	2
340377	S MONMOUTH S.A.	8.00	04	NEW JERSEY	MONMOUTH	125	4
340383	HAMILTON TOWNSHIP	16.00	03	NEW JERSEY	MERCER	011	2
340386	BERGEN CO SEWER AUTHORITY	75.00	03	NEW JERSEY	BERGEN	022	2
340388	HANOVER SEWER AUTHORITY	3.00	03	NEW JERSEY	MORRIS	022	1
340550	CUMBERLAND CO. SEWERAGE A	7.00	03	NEW JERSEY	CUMBERLAND	011	1
350171	LAS CRUCES WWTP	6.00	03	NEW MEXICO	DONA ANA	012	1
350188	CITY OF LORDSBURG WWTP	.80	03	NEW MEXICO	HILDALGO	012	1
351029	CITY OF PORTALES WWTP	1.14	03	NEW MEXICO	ROOSEVELT	012	1
360389	RENSSELAER COUNTY S.D.	24.00	03	NEW YORK	RENSSELAER	022	2
360391	TONWANDA STP IMP	30.00	06	NEW YORK	ERIE	121	3
360433	SAG HARBOR SEWAGE SYS	.10	03	NEW YORK	SUFFOLK	022	1
360446	CLAYTON STP	.30	03	NEW YORK	JEFFERSON	022	1
360485	ONTARIO TOWN SEWERAGE SYS	1.00	04	NEW YORK	WAYNE	121	4
360495	N TONAWANDA WTW	10.00	06	NEW YORK	NIAGARA	121	3
360534	SACKETS HARBOR STP	.60	03	NEW YORK	JEFFERSON	022	1
360567	NEW ROCHELLE S.D.	13.60	03	NEW YORK	WESTCHESTER	022	2
360618	AMHERST SEW SYS	24.00	04	NEW YORK	ERIE	121	3
360621	GREENPORT	.50	03	NEW YORK	SUFFOLK	022	1
360640	WALTON STP & SEWERS	1.17	04	NEW YORK	DELAWARE	104	4
360644	WATERFORD SEWERAGE SYSTEM	1.50	03	NEW YORK	SARATOGA	022	1
360646	COBLESKILL WTW	.75	04	NEW YORK	SCHOHARIE	104	4
360650	GROTON WTW	.25	03	NEW YORK	TOMPKINS	022	1
360659	SYRACUSE METRO	80.00	07	NEW YORK	ONODAGA	121	3
360680	CHAUTAUQUA LAKE SO	4.10	03	NEW YORK	CHAUTAUQUA	022	1
360691	ORANGE CO.S.D #1	2.00	04	NEW YORK	ORANGE	104	4
360707	NIAGARA COUNTY S.D.#1	14.10	07	NEW YORK	NIAGARA	121	3
360742	LISHAKILL COLONIE	5.00	03	NEW YORK	ALBANY	022	1
360747	NIAGARA FALLS AWT	48.00	07	NEW YORK	NIAGARA	121	3
360750	CHAMPLAIN PK S.D.	.16	04	NEW YORK	CLINTON	121	4
360771	WESTFIELD SEWER IMPROVEM	2.60	06	NEW YORK	CHAUTAUQUA	121	4
360783	OCEAN BEACH STP	.50	04	NEW YORK	SUFFOLK	104	4
360786	WATKINS GLEN STP	.70	03	NEW YORK	SCHUYLER	022	1
360812	SODUS POINT STP	.57	03	NEW YORK	WAYNE	022	1
360824	ALBION AWT	2.00	07	NEW YORK	ORLEANS	121	4
360854	DEPOSIT SEWERAGE SYSTEM	.40	03	NEW YORK	BROOME	022	1
360859	MARATHON SEWER SYSTEM	.20	03	NEW YORK	CORTLAND	022	1
370364	TARBORO WTW	3.00	03	N. CAROLINA	EDGECOMBE	005	1
370382	CONCORD WTW	24.00	04	N. CAROLINA	CABARRUS	105	3
370383	FARMVILLE WTW	3.50	07	N. CAROLINA	EDGECOMBE	105	4
370425	CLINTON STP	3.00	06	NORTH CAROLINA	SAMPSON	105	4
370434	SPRING LAKE	1.50	04	NORTH CAROLINA	CUMBERLAND	105	4
370441	MOORE COUNTY REG. WTW	6.70	06	NORTH CAROLINA	MOORE	105	4

380294	ENDERLIN WTW & SS	.25	03	NORTH DAKOTA	RANSOM	002	1
380313	SHELDON LAGOON AND CS	.03	03	NORTH DAKOTA	RANSOM	002	1
380321	BISMARCK WWTP	5.04	03	NORTH DAKOTA	BURLEIGH	002	1
380329	DICKINSON LAGOONS	1.49	03	NORTH DAKOTA	STARK	002	1
380332	CRARY WWTP	.02	03	NORTH DAKOTA	RAMSEY	002	1
390464	VAN WERT	2.75	07	OHIO	VAN WERT	107	4
390471	CLEVELAND RSD SOUTHERLY	200.00	06	OHIO	CUYAHOGA	108	3
390471	CLEVELAND RSD SOUTHERLY	200.00	06	OHIO	CUYAHOGA	108	3
390514	RAVENNA	2.80	07	OHIO	PORTAGE	108	4
390556	LITTLE MIAMI WWTP	38.00	06	OHIO	HAMILTON	107	3
390577	LONDON	1.50	04	OHIO	MADISON	108	4
390584	PORTSMOUTH TREATMENT PLT	4.00	06	OHIO	SCIOTO	107	4
390586	MINERAL CITY	.15	03	OHIO	TUSCARAWAS	014	1
390589	OAK HARBOR WWTP	.74	03	OHIO	OTTAWA	014	1
390590	PLEASANT HILL	.20	03	OHIO	MIAMI	014	1
390591	EUCLID	22.00	07	OHIO	CUYAHOGA	108	3
390593	MOUNT VERNON WWTP	5.00	06	OHIO	KNOX	108	4
390599	URBANA WWTP	3.00	06	OHIO	CHAMPAIGN	107	4
390622	CANTON	35.00	04	OHIO	STARK	108	3
390624	GEAUGA CO,MCFARLAND CREEK	1.20	07	OHIO	GEAUGA	108	4
390626	LIMA WWTP	18.50	07	OHIO	ALLEN	107	3
390627	MASSILLON	12.00	07	OHIO	STARK	108	3
390630	BURTON WWTP	.27	04	OHIO	GEAUGA	108	3
390644	CIRCLEVILLE	3.50	06	OHIO	PICKAWAY	108	4
390648	OREGON WWTP	8.00	07	OHIO	LUCAS	111	4
390654	HAMILTON	24.70	06	OHIO	BUTLER	107	3
390657	MEDINA COUNTY REGIONAL TP	2.00	07	OHIO	MEDINA	108	4
390663	HASKINS WWTP	.10	04	OHIO	WOOD	111	4
390680	NEW KNOXVILLE WWTP	.12	04	OHIO	AUGLAIZE	107	4
390683	FRENCH CREEK STP	7.50	07	OHIO	LORAINE	108	4
390684	MEAWDER WATERSHED, ETAL.	4.00	07	OHIO	MAHONING	121	4
390686	FAIRFIELD	6.00	07	OHIO	BUTLER	107	4
390702	MONTGOMERY CO WEST REG PT	20.00	07	OHIO	MONTGOMERY	107	3
390717	PROSPECT	.12	03	OHIO	MARION	014	1
390741	CLEVELAND RSD-SOUTHERLY	200.00	06	OHIO	CUYAHOBA	108	3
390753	BLOOMINGBURG	.16	04	OHIO	FAYETTE	107	4
390754	SHERWOOD WWTP	.16	03	OHIO	DEFIANCE	111	4
390893	COLUMBUS	100.00	04	OHIO	FRANKLIN	108	3
390957	SWANTON WWTP	.92	07	OHIO	FULTON	111	4
390982	SOUTH POINT WWTP	1.20	03	OHIO	LAWRENCE	014	1
390999	LIVERPOOL WWTP	10.00	07	OHIO	MEDINA	108	3
391001	PREBLE COUNTY WWTP	.60	07	OHIO	PREBLE	107	4
391005	ASHLEY	.19	07	OHIO	DELAWARE	108	4
400537	WEWOKA WWTP	.75	04	OKLAHOMA	SEMINOLE	109	4
400638	AMBER LAGOONS	.04	03	OKLAHOMA	GRADY	023	1
400644	COTTON COUNTY RWD LAGOON	.05	08	OKLAHOMA	COTTON	023	1
400648	ALTUS WWTP	2.00	06	OKLAHOMA	JACKSON	109	4
400674	STILLWATER WWTP	6.00	04	OKLAHOMA	PAYNE	109	4
400682	PERRY WWTP	.75	04	OKLAHOMA	NOBLE	109	4
400743	MARTHA LAGOONS	.03	08	OKLAHOMA	JACKSON	023	1
400779	NO CANADIAN WWTP	40.00	03	OKLAHOMA	OKLAHOMA	023	2
410320	WILLOW LAKE STP	35.00	03	OREGON	MARION/POLK	008	2
410341	TRYON CREEK STP	10.50	04	OREGON	CLACKAMAS	123	3
410355	CORVALLIS STP	9.70	07	OREGON	BENTON	123	4
410365	DEPOE BAY STP	.80	03	OREGON	LINCOLN	008	1
410371	DURHAM WWTP	20.00	07	OREGON	WASHINGTON	123	3
410411	REDWOOD SANITARY DISTRICT	.50	03	OREGON	JOSEPHINE	008	1
410416	CLOVERDALE STP	.04	04	OREGON	TILLAMOOK	123	4
410446	LEBANON STP	3.00	04	OREGON	LINN	123	4
410485	ROCK CREEK AWTP	15.00	07	OREGON	WASHINGTON	123	3

420572	HICKORY TWP MUNIC.AUTH.	2.50	04	PENN	MERCER	121	4
420585	LOCK HAVEN STP	3.75	03	PENN	CLINTON	022	1
420600	VALLEY FORGE SEWER AUTH	8.00	03	PENNSYLVANIA	CHESTER	011	1
420622	PORTAGE JOINT SEWER AUTH	1.00	03	PENNSYLVANIA	CAMBRIA	006	1
420643	ELIZABETHVILLE	.28	03	PENNSYLVANIA	DAUPHIN	011	1
420657	TRI-BORO MUNICIPAL AUTH	.50	03	PENN	SUSQUEHANNA	011	1
420701	MOSHANNON VALLEY J.S.A.	1.50	03	PENNSYLVANIA	CENTRE	022	1
420704	OIL CITY GENERAL AUTH.	4.00	03	PENNSYLVANIA	VENANGO	022	1
420707	MC CANDLESS TWP SAN.AUTH	3.00	03	PENNSYLVANIA	ALLEGHENY	025	1
420711	HAMILTONBAN TWP AUTH	.03	03	PENNSYLVANIA	ADAMS	011	1
420712	OLEY TWP MUNICIPAL AUTH	.25	04	PENNSYLVANIA	BERKS	120	4
420715	MIDDLETOWN BOROUGH AUTH	2.20	06	PENNSYLVANIA	DAUPHIN	120	4
420718	SHOEMAKERSVILLE MWWTF	.35	06	PENNSYLVANIA	BERKS	120	4
420720	MONTGOMERY W & S AUTHORIT	.60	04	PENNSYLVANIA	LYCOMING	121	4
420723	ADAMS TOWNSHIP	.03	03	PENNSYLVANIA	CAMBRIA	006	1
420724	UPPER STONYCREEK J.M.A.	.27	03	PENNSYLVANIA	SOMERSET	006	1
420728	MILTON MUNICIPAL AUTHORIT	2.60	03	PENNSYLVANIA	NORTHUMBERLAN	011	1
420733	THOMPSONTOWN MUNICIPAL A.	.11	03	PENNSYLVANIA	JUNIATA	011	1
420737	NEW KENSINGTON M.S.A.	7.00	03	PENNSYLVANIA	WESTMORELAND	025	1
420738	YORK CITY SEWER AUTHORITY	26.00	06	PENN	YORK	102	3
420739	POINT MARION MUNICIPAL AU	.30	03	PENNSYLVANIA	FAYETTE	025	1
420740	PENNRIDGE WASTEWATER TREA	4.00	06	PENNSYLVANIA	MONTGOMERY	120	4
420742	TREMONT MUNICIPAL AUTH	.33	06	PENNSYLVANIA	SCHUYLKILL	120	4
4[illegible]749	CORAOPOLIS STP	3.00	03	PENNSYLVANIA	ALLEGHENY	025	1
420760	SYKESVILLE MUNICIPAL AUTH	.20	03	PENNSYLVANIA	JEFFERSON	022	1
420775	CARMICHAELS-CUMBERLAND ST	.60	03	PENNSYLVANIA	GREENE	025	1
420781	SCHUYLKILL HAVEN MUNIC.A	2.00	06	PENNSYLVANIA	SCHUYLKILL	120	4
420783	BROWN TWP MUNICIPAL AUTH	.25	03	PENNSYLVANIA	MIFFLIN	011	1
420820	MOUNTAINTOP AREA	1.83	03	PENNSYLVANIA	LUZERNE	011	1
420831	ALLENTOWN AUTHORITY	40.00	06	PENN	LEGHIGH	120	3
420917	PORTER-TOWER JOINT M.A.	.43	06	PENNSYLVANIA	SCHUYLKILL	120	4
421004	HARRISBURG SEWERAGE AUTH.	30.90	06	PENN	DAUPHIN	120	3
440074	BLOCK ISLAND WWTP	.28	03	RHODE ISLAND	WASHINGTON	022	1
440086	SMITHFIELD REGIONAL WWTF	3.50	04	RHODE ISLAND	PROVIDENCE	104	4
450265	SANTEE PUBLIC SERVICE DIS	.30	04	SOUTH CAROLINA	ORANGEBURG	105	4
460222	VIVIAN LAGOON & COLL.SYS.	.02	08	SOUTH DAKOTA	LYMAN	017	1
460238	RAMONA WWT PONDS	.03	08	SOUTH DAKOTA	LAKE	021	1
460259	HENRY WWT POND	.02	08	SOUTH DAKOTA	CODINGTON	021	1
460472	BRUCE LAGOON & COLL. SYS.	.03	08	SOUTH DAKOTA	BROOKINGS	021	1
470352	GATLINBURG WWTP	3.00	07	TENNESSEE	SEVIER	103	4
470355	MCEWEN STP	.50	07	TENNESSEE	HUMPHREYS	103	4
470374	SINKING CREEK WWTP	8.00	07	TENNESSEE	RUTHERFORD	103	4
480799	BLOOMING GROVE WWTP	.10	04	TEXAS	NAVARRO	109	4
480856	CROCKETT WWTP	1.00	03	TEXAS	HOUSTON	024	1
480878	MERTZON WWTP	.05	03	TEXAS	IRION	024	1
480938	KERRVILLE CITY WWTP	2.05	03	TEXAS	KERR	024	1
480952	SU FUR SPRINGS WWTP	2.50	04	TEXAS	HOPKINS	109	4
480981	CROSBY WWTP	.25	04	TEXAS	HARRIS	112	4
481017	VILLAGE CREEK WWTP	96.00	07	TEXAS	TARRANT	109	3
481021	LONGVIEW WWTP	15.60	07	TEXAS	GREGG	109	3
481048	BAYTOWN CITY WWTP	3.00	04	TEXAS	HARRIS	112	4
481062	BURKBURNETT WWTP	2.20	03	TEXAS	WICHITA	024	1
481084	CLEAR LAKE CITY WWTP	4.50	06	TEXAS	HARRIS	112	4
481110	SILVER LAKE WWTP	1.00	04	TEXAS	VAL VERDE	112	4
481116	CONROE WWTP	20.00	04	TEXAS	MONTGOMERY	112	3
490142	CEDAR CITY WWTP	2.26	04	UTAH	IRON	110	4
490152	HYRUM CITY WWTP & COLL.	.88	04	UTAH	CACHE	110	4
490170	GRANGER - HUNTER IMP DIST	7.30	04	UTAH	SALT LAKE	110	4
490175	TROPIC TOWN OF	.04	03	UTAH	GARFIELD	015	1
490181	EMERY TOWN PONDS & COLL.	.03	08	UTAH	EMERY	015	1

490194	PROVO CITY WWTP	21.00	04	UTAH	UTAH	110	3
500079	BRANDON WWTP	.70	03	VERMONT	RUTLAND	003	1
500081	HARTFORD WWTP	1.00	03	VERMONT	WINDSOR	003	1
500083	NORTH BRANCH F.D. STP	.82	03	VERMONT	WINDHAM	003	1
500089	ENOSBORG FALLS	.26	03	VERMONT	FRANKLIN	003	1
510259	UPPER SMITH RIVER WWTP	4.00	03	VIRGINIA	HENRY	018	1
510314	GALAX STP	1.50	03	VIRGINIA	GRAYSON	018	1
510331	UPPER OCCOQUAN REGIONAL	22.50	07	VIRGINIA	PRINCE WILLIA	102	3
510355	CLIFTON FORGE STP	2.00	03	VIRGINIA	ALLEGHANY	018	1
510356	ALEXANDRIA STP	54.00	07	VIRGINIA	FAIRFAX	102	3
510357	ARLINGTON COUNTY	30.00	06	VIRGINIA	ARLINGTON	102	3
510370	ROANOKE STP	35.00	02	VIRGINIA	ROANOKE	018	2
510375	STUART STP	.30	03	VIRGINIA	PATRICK	018	1
510383	ROUND HILL	.10	04	VIRGINIA	LOUDOUN	102	4
510384	WAVERLY STP	.35	03	VIRGINIA	SUSSEX	011	1
510396	LEXINGTON STP	2.00	03	VIRGINIA	ROCKBRIDGE	018	1
510442	ROANOKE STP	35.00	07	VIRGINIA	ROANOKE	102	3
510447	PLAINS-MARSHALL REGIONAL	.16	04	VIRGINIA	FAUQUIER	102	4
510485	CULPEPER STP	3.00	04	VIRGINIA	CULPEPER	102	4
510490	MCKENNEY STP	.10	03	VIRGINIA	DINWIDDIE	011	1
510498	BLACKBURG-VPI SAN.AUTH	6.00	03	VIRGINIA	MONTGOMERY	018	1
510500	REEDVILLE ST	.20	03	VIRGINIA	NORTHUMBERLAN	011	1
510515	POUND STP	.18	03	VIRGINIA	WISE	018	1
510517	MARTINSVILLE STP	6.00	03	VIRGINIA	HENRY	018	1
530466	BIRCH BAY(WHATCOM CO WD#8	1.60	03	WASHINGTON	WHATCOM	008	1
530488	WESTPORT WWTF	1.00	03	WASHINGTON	GRAYS HARBOR	008	1
530504	OLYMPIA STP	9.10	03	WASHINGTON	THURSTON	008	1
530513	ARLINGTON STP	1.00	03	WASHINGTON	SNOHAMISH	008	1
530516	BURLINGTON STP	1.20	03	WASHINGTON	SKAGIT	008	1
530530	WEST LONGVIEW STP	.20	03	WASHINGTON	COWLITZ	008	1
530549	STEVENS PASS-YODELIN STP	.06	04	WASHINGTON	KING/CHELAN	124	4
530553	WHITE SWAN W&S	.10	08	WASHINGTON	YAKIMA	008	1
530580	SPOKANE WWTF	40.00	06	WASHINGTON	SPOKANE	124	3
530740	GLENWOOD STP(KLICKITAT CO	.10	03	WASHINGTON	KLICKITAT	008	1
540198	WEIRTON STP	4.00	02	WEST VIRGINIA	BROOKE	025	1
540208	DELBARTON	.12	04	WEST VIRGINIA	MINGO	121	4
540213	BLUEFIELD	3.50	07	WEST VIRGINIA	MERCER	121	4
540424	ST. ALBANS STP	2.50	03	WEST VIRGINIA	KANAWHA	006	1
550488	TWO RIVERS	4.40	07	WISCONSIN	MANITOWOC	116	4
550548	SUPERIOR STP	5.00	06	WISCONSIN	DOUGLAS	117	4
550552	RACINE STP	30.00	06	WISCONSIN	RACINE	116	3
550569	MT HOREB WWTP	.79	07	WISCONSIN	DANE	116	4
550573	LOMIRA WWTP	.49	04	WISCONSIN	DODGE	116	4
550625	MONTREAL WWTP	.20	03	WISCONSIN	IRON	117	4
550631	OCONOMOWOC WWTP	4.02	04	WISCONSIN	WAUKESHA	116	4
550648	MANITOWOC WWTP	15.50	06	WISCONSIN	MANITOWOC	116	3
550662	RHINELANDER STP	1.90	03	WISCONSIN	ONEIDA	010	1
550686	KEWAUNEE WWTP	.58	06	WISCONSIN	KEWAUNEE	116	4
550687	RIPON STP	2.00	07	WISCONSIN	FOND DU LAC	116	4
550689	HOLLAND STP	.20	07	WISCONSIN	BROWN	116	4
550706	DEPERE WWTP	14.20	06	WISCONSIN	BROWN	116	3
550734	MADISON MSD	51.[illegible]0	03	WISCONSIN	DALE	010	2
550787	MARSHFIELD STP	3.50	04	WISCONSIN	WOOD	116	4
550788	FOND DU LAC	25.00	07	WISCONSIN	FOND DU LAC	116	3
550790	STOUGHTON WWTP	1.65	03	WISCONSIN	DANE	010	1
550790	STOUGHTON STP	1.65	03	WISCONSIN	DANE	010	1
550794	CASCO	.07	03	WISCONSIN	KEWAUNEE	010	1
550820	NORTHERN MORAINE UC STP	.60	03	WISCONSIN	SHEBOYGAN	010	1
550831	APPLETON STP	16.50	07	WISCONSIN	OUTAGAMIE	116	3
560104	COWLEY STP & COLL.	.65	08	WYOMING	BIG HORN	004	1

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560109	CASPER WWTP	6.40	03	WYOMING	NATRONA	004	1
560110	LABARGE WWTP & COLL. SYS.	.04	03	WYOMING	LINCOLN	015	1
660007	NORTHERN DIST WWTF	12.00	01	GUAM	GUAM	126	2

TABLE B.2

DISTRIBUTION OF WWTP SAMPLE BY PROJECTED FLOW AND LEVEL OF TREATMENT

	< 1.00 MGD				1.00 - 5.00 MGD				5.01 - 25.00 MGD				> 25.00 MGD				
	PROJECTED LEVEL OF TREATMENT				PROJECTED LEVEL OF TREATMENT				PROJECTED LEVEL OF TREATMENT				PROJECTED LEVEL OF TREATMENT				
	1-2	3&8	4-7	TOTAL	1-2	3&8	4-7	TOTAL	1-2	3&8	4-7	TOTAL	1-2	3&8	4-7	TOTAL	TOTALS
REGION 01	1	8	0	9	0	7	1	8	0	4	1	5	0	2	0	2	24
CONNECTICUT	0	1	0	1	0	1	0	1	0	2	0	2	0	0	0	0	4
MAINE	0	1	0	1	0	2	0	2	0	1	0	1	0	0	0	0	4
MASSACHUSETTS	0	1	0	1	0	2	0	2	0	1	0	1	0	1	0	1	5
NEW HAMPSHIRE	1	1	0	2	0	1	0	1	0	0	1	1	0	1	0	1	5
RHODE ISLAND	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	2
VERMONT	0	3	0	3	0	1	0	1	0	0	0	0	0	0	0	0	4
REGION 02	0	9	3	12	0	5	6	11	0	7	5	12	0	4	3	7	42
NEW JERSEY	0	0	0	0	0	2	1	3	0	5	2	7	0	4	0	4	14
NEW YORK	0	9	3	12	0	3	5	8	0	2	3	5	0	0	3	3	28
PUERTO RICO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIRGIN ISLANDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REGION 03	0	21	11	32	1	16	8	25	0	5	1	6	1	0	8	9	72
DELAWARE	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	2
WASHINGTON DC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARYLAND	0	6	2	8	0	3	1	4	0	1	0	1	0	0	2	2	15
PENNSYLVANIA	0	10	5	15	0	8	4	12	0	2	0	2	0	0	3	3	32
VIRGINIA	0	5	2	7	0	4	1	5	0	2	1	3	1	0	3	4	19
WEST VIRGINIA	0	0	1	1	1	1	1	3	0	0	0	0	0	0	0	0	4
REGION 04	0	3	3	6	0	1	5	6	0	0	6	6	0	0	1	1	19
ALABAMA	0	2	0	2	0	0	1	1	0	0	0	0	0	0	0	0	3
FLORIDA	0	0	0	0	0	0	0	0	0	0	3	3	0	0	1	1	4
GEORGIA	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	2
KENTUCKY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSISSIPPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NORTH CAROLINA	0	0	0	0	0	1	3	4	0	0	2	2	0	0	0	0	6
SOUTH CAROLINA	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
TENNESSEE	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	3
REGION 05	1	28	51	80	0	8	55	63	0	4	29	33	0	8	14	22	198
ILLINOIS	1	6	13	20	0	1	19	20	0	2	11	13	0	5	1	6	59
INDIANA	0	6	21	27	0	1	7	8	0	2	2	4	0	0	1	1	40
MICHIGAN	0	3	4	7	0	1	10	11	0	0	2	2	0	0	3	3	23
MINNESOTA	0	5	2	7	0	1	4	5	0	0	1	1	0	2	2	4	17
OHIO	0	5	7	12	0	1	10	11	0	0	9	9	0	0	6	6	38
WISCONSIN	0	3	4	7	0	3	5	8	0	0	4	4	0	1	1	2	21

TABLE B.2 (Continued)

DISTRIBUTION OF WWTP SAMPLE
BY PROJECTED FLOW AND LEVEL OF TREATMENT

	< 1.00 MGD				1.00 - 5.00 MGD				5.01 - 25.00 MGD				> 25.00 MGD				
	PROJECTED LEVEL OF TREATMENT				PROJECTED LEVEL OF TREATMENT				PROJECTED LEVEL OF TREATMENT				PROJECTED LEVEL OF TREATMENT				
	1-2	3&8	4-7	TOTAL	1-2	3&8	4-7	TOTAL	1-2	3&8	4-7	TOTAL	1-2	3&8	4-7	TOTAL	TOTALS
REGION 06	0	9	5	14	0	8	6	14	0	2	4	6	0	1	1	2	36
ARKANSAS	0	0	1	1	0	1	1	2	0	1	1	2	0	0	0	0	5
LOUISIANA	0	4	0	4	0	3	0	3	0	0	0	0	0	0	0	0	7
NEW MEXICO	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	3
OKLAHOMA	0	3	2	5	0	0	1	1	0	0	1	1	0	1	0	1	8
TEXAS	0	1	2	3	0	3	4	7	0	0	2	2	0	0	1	1	13
REGION 07	0	6	3	9	0	4	3	7	1	3	1	5	0	1	1	2	23
IOWA	0	1	1	2	0	0	2	2	0	1	1	2	0	0	1	1	7
KANSAS	0	1	1	2	0	1	0	1	1	0	0	1	0	0	0	0	4
MISSOURI	0	1	1	2	0	2	0	2	0	1	0	1	0	1	0	1	6
NEBRASKA	0	3	0	3	0	1	1	2	0	1	0	1	0	0	0	0	6
REGION 08	0	15	2	17	0	1	3	4	0	6	3	9	0	0	0	0	30
COLORADO	0	2	1	3	0	0	1	1	0	1	1	2	0	0	0	0	6
MONTANA	0	2	0	2	0	0	1	1	0	3	0	3	0	0	0	0	6
NORTH DAKOTA	0	3	0	3	0	1	0	1	0	1	0	1	0	0	0	0	5
SOUTH DAKOTA	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4
UTAH	0	2	1	3	0	0	1	1	0	0	2	2	0	0	0	0	6
WYOMING	0	2	0	2	0	0	0	0	0	1	0	1	0	0	0	0	3
REGION 09	1	21	0	22	0	11	4	15	2	6	6	14	2	3	6	11	62
ARIZONA	0	3	0	3	0	1	1	2	0	1	0	1	0	0	0	0	6
CALIFORNIA	1	10	0	11	0	7	3	10	0	5	6	11	1	3	5	9	41
HAWAII	0	2	0	2	0	1	0	1	1	0	0	1	1	0	0	1	5
NEVADA	0	6	0	6	0	2	0	2	0	0	0	0	0	0	1	1	9
AMERICAN SAMOA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GUAM	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1
TRUST TERR.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REGION 10	0	12	2	14	0	6	1	7	0	3	4	7	0	1	1	2	30
ALASKA	0	3	0	3	0	1	0	1	0	1	0	1	0	0	0	0	5
IDAHO	0	4	0	4	0	1	0	1	0	1	0	1	0	0	0	0	6
OREGON	0	2	1	3	0	0	1	1	0	0	4	4	0	1	0	1	9
WASHINGTON	0	3	1	4	0	4	0	4	0	1	0	1	0	0	1	1	10
NATIONAL TOTALS	3	132	80	215	1	67	92	160	3	40	60	103	3	20	35	58	536

TABLE B.3

DISTRIBUTION OF WWTP SAMPLE
BY TYPE OF PROJECTED CHANGE

	ENLARGE (CODE 01)	UPGRADE (CODE 02)	ENLARGE AND UPGRADE (CODE 03)	NEW CONSTRUCTION (CODE 04)	REPLACE (CODE 05)	ABANDON (CODE 06)	NO CHANGE (CODE 07)	MODIFICATION (CODE 08)	OTHER (CODE 09)	TOTALS
REGION 01	0	0	2	22	0	0	0	0	0	24
CONNECTICUT	0	0	1	3	0	0	0	0	0	4
MAINE	0	0	0	4	0	0	0	0	0	4
MASSACHUSETTS	0	0	0	5	0	0	0	0	0	5
NEW HAMPSHIRE	0	0	0	5	0	0	0	0	0	5
RHODE ISLAND	0	0	0	2	0	0	0	0	0	2
VERMONT	0	0	1	3	0	0	0	0	0	4
REGION 02	3	3	9	20	7	0	0	0	0	42
NEW JERSEY	3	0	5	5	1	0	0	0	0	14
NEW YORK	0	3	4	15	6	0	0	0	0	28
PUERTO RICO	0	0	0	0	0	0	0	0	0	0
VIRGIN ISLANDS	0	0	0	0	0	0	0	0	0	0
REGION 03	5	6	20	36	5	0	0	0	0	72
DELAWARE	0	0	0	1	1	0	0	0	0	2
WASHINGTON DC	0	0	0	0	0	0	0	0	0	0
MARYLAND	3	0	1	11	0	0	0	0	0	15
PENNSYLVANIA	1	2	12	15	2	0	0	0	0	32
VIRGINIA	1	2	7	8	1	0	0	0	0	19
WEST VIRGINIA	0	2	0	1	1	0	0	0	0	4
REGION 04	0	1	7	9	2	0	0	0	0	19
ALABAMA	0	0	0	3	0	0	0	0	0	3
FLORIDA	0	0	4	0	0	0	0	0	0	4
GEORGIA	0	0	0	1	1	0	0	0	0	2
KENTUCKY	0	0	0	0	0	0	0	0	0	0
MISSISSIPPI	0	0	0	0	0	0	0	0	0	0
NORTH CAROLINA	0	1	1	4	0	0	0	0	0	6
SOUTH CAROLINA	0	0	0	1	0	0	0	0	0	1
TENNESSEE	0	0	2	0	1	0	0	0	0	3
REGION 05	13	25	96	58	2	0	0	4	0	198
ILLINOIS	5	10	40	3	0	0	0	1	0	59
INDIANA	2	2	15	21	0	0	0	0	0	40
MICHIGAN	0	5	15	3	0	0	0	0	0	23
MINNESOTA	2	0	5	10	0	0	0	0	0	17
OHIO	1	3	15	16	0	0	0	3	0	38
WISCONSIN	3	5	6	5	2	0	0	0	0	21
REGION 06	6	0	9	16	5	0	0	0	0	36
ARKANSAS	0	0	2	2	1	0	0	0	0	5
LOUISIANA	2	0	0	5	0	0	0	0	0	7
NEW MEXICO	1	0	0	1	1	0	0	0	0	3
OKLAHOMA	0	0	2	6	0	0	0	0	0	8
TEXAS	3	0	5	2	3	0	0	0	0	13

TABLE B.3 (Continued)

DISTRIBUTION OF WWTP SAMPLE
BY TYPE OF PROJECTED CHANGE

	ENLARGE (CODE 01)	UPGRADE (CODE 02)	ENLARGE AND UPGRADE (CODE 03)	NEW CONSTRUCTION (CODE 04)	REPLACE (CODE 05)	ABANDON (CODE 06)	NO CHANGE (CODE 07)	MODIFICATION (CODE 08)	OTHER (CODE 09)	TOTALS
REGION 07	0	1	8	11	3	0	0	0	0	23
IOWA	0	1	3	3	0	0	0	0	0	7
KANSAS	0	0	2	2	0	0	0	0	0	4
MISSOURI	0	0	1	4	1	0	0	0	0	6
NEBRASKA	0	0	2	2	2	0	0	0	0	6
REGION 08	2	1	7	16	1	0	0	3	0	30
COLORADO	1	0	2	2	1	0	0	0	0	6
MONTANA	0	10	1	2	0	0	0	2	0	6
NORTH DAKOTA	1	0	2	2	0	0	0	0	0	5
SOUTH DAKOTA	0	0	0	4	0	0	0	0	0	4
UTAH	0	0	1	4	0	0	0	1	0	6
WYOMING	0	0	1	2	0	0	0	0	0	3
REGION 09	3	7	27	19	5	0	0	1	0	62
ARIZONA	0	0	1	4	1	0	0	0	0	6
CALIFORNIA	3	6	21	7	3	0	0	1	0	41
HAWAII	0	0	1	4	0	0	0	0	0	5
NEVADA	0	1	4	3	1	0	0	0	0	9
AMERICAN SAMOA	0	0	0	0	0	0	0	0	0	0
GUAM	0	0	0	1	0	0	0	0	0	1
TRUST TERR.	0	0	0	0	0	0	0	0	0	0
REGION 10	0	0	10	19	0	0	0	1	0	30
ALASKA	0	0	0	5	0	0	0	0	0	5
IDAHO	0	0	1	4	0	0	0	1	0	6
OREGON	0	0	4	5	0	0	0	0	0	9
WASHINGTON	0	0	5	5	0	0	0	0	0	10
NATIONAL TOTALS	32	44	195	226	30	0	0	9	0	536

TABLE B.4

DISTRIBUTION OF WWTP SAMPLE
BY SMSA, NON-SMSA, AND LAND USE

	SMSA	NON-SMSA	AGRICULTURAL (11-14)	RESIDENTIAL (21-24)	DENSE RESIDENTIAL (31-34)	COMMERCIAL (41-44)	DENSE COMMERCIAL (51-54)	INDUSTRIAL (61-64)	DENSE INDUSTRIAL (71-74)	MUNICIPAL (81-84)
REGION 01	14	10	11	0	0	0	0	3	0	8
CONNECTICUT	3	1	1	0	0	0	0	2	0	1
MAINE	2	2	1	0	0	0	0	0	0	2
MASSACHUSETTS	3	2	1	0	0	0	0	0	0	4
NEW HAMPSHIRE	4	1	4	0	0	0	0	1	0	0
RHODE ISLAND	2	0	1	0	0	0	0	0	0	1
VERMONT	0	4	3	0	0	0	0	0	0	0
REGION 02	28	14	17	0	0	3	0	1	0	20
NEW JERSEY	11	3	5	0	0	0	0	0	0	9
NEW YORK	17	11	12	0	0	3	0	1	0	11
PUERTO RICO	0	0	0	0	0	0	0	0	0	0
VIRGIN ISLANDS	0	0	0	0	0	0	0	0	0	0
REGION 03	33	39	31	0	0	0	0	0	0	32
DELAWARE	1	1	1	0	0	0	0	0	0	0
WASHINGTON DC	0	0	0	0	0	0	0	0	0	0
MARYLAND	7	8	8	0	0	0	0	0	0	4
PENNSYLVANIA	16	16	11	0	0	0	0	0	0	16
VIRGINIA	7	12	9	0	0	0	0	0	0	10
WEST VIRGINIA	2	2	2	0	0	0	0	0	0	2
REGION 04	6	13	10	0	0	0	0	0	0	7
ALABAMA	1	2	3	0	0	0	0	0	0	0
FLORIDA	4	0	0	0	0	0	0	0	0	2
GEORGIA	0	2	1	0	0	0	0	0	0	1
KENTUCKY	0	0	0	0	0	0	0	0	0	0
MISSISSIPPI	0	0	0	0	0	0	0	0	0	0
NORTH CAROLINA	1	5	4	0	0	0	0	0	0	2
SOUTH CAROLINA	0	1	1	0	0	0	0	0	0	0
TENNESSEE	0	3	1	0	0	0	0	0	0	2
REGION 05	98	100	49	2	0	1	0	1	0	143
ILLINOIS	35	24	4	0	0	0	0	1	0	54
INDIANA	13	27	18	0	0	0	0	0	0	22
MICHIGAN	8	15	3	0	0	0	0	0	0	20
MINNESOTA	6	11	8	0	0	0	0	0	0	8
OHIO	27	11	11	2	0	1	0	0	0	23
WISCONSIN	9	12	5	0	0	0	0	0	0	16
REGION 06	7	29	12	9	1	1	0	0	0	12
ARKANSAS	0	5	3	0	0	0	0	0	0	2
LOUISIANA	0	7	2	4	0	1	0	0	0	0
NEW MEXICO	0	3	1	1	0	0	0	0	0	0
OKLAHOMA	1	7	6	0	0	0	0	0	0	2
TEXAS	6	7	0	4	1	0	0	0	0	8

TABLE B.4 (Continued)

DISTRIBUTION OF WWTP SAMPLE
BY SMSA, NON-SMSA, AND LAND USE

	SMSA	NON-SMSA	AGRICULTURAL (11-14)	RESIDENTIAL (21-24)	DENSE RESIDENTIAL (31-34)	COMMERCIAL (41-44)	DENSE COMMERCIAL (51-54)	INDUSTRIAL (61-64)	DENSE INDUSTRIAL (71-74)	MUNICIPAL (81-84)
REGION 07	5	18	13	0	0	0	0	0	0	7
IOWA	2	5	2	0	0	0	0	0	0	3
KANSAS	0	4	3	0	0	0	0	0	0	1
MISSOURI	2	4	5	0	0	0	0	0	0	1
NEBRASKA	1	5	3	0	0	0	0	0	0	2
REGION 08	8	22	15	0	0	1	0	0	0	9
COLORADO	4	2	1	0	0	1	0	0	0	4
MONTANA	2	4	2	0	0	0	0	0	0	1
NORTH DAKOTA	0	5	3	0	0	0	0	0	0	2
SOUTH DAKOTA	0	4	3	0	0	0	0	0	0	0
UTAH	2	4	4	0	0	0	0	0	0	1
WYOMING	0	3	2	0	0	0	0	0	0	1
REGION 09	34	28	17	2	0	0	0	2	0	41
ARIZONA	3	3	0	2	0	0	0	0	0	4
CALIFORNIA	25	16	10	0	0	0	0	1	0	30
HAWAII	2	3	1	0	0	0	0	1	0	3
NEVADA	4	5	5	0	0	0	0	0	0	4
AMERICAN SAMOA	0	0	0	0	0	0	0	0	0	0
GUAM	0	1	1	0	0	0	0	0	0	0
TRUST TERR.	0	0	0	0	0	0	0	0	0	0
REGION 10	9	21	14	1	0	0	0	4	0	11
ALASKA	0	5	1	0	0	0	0	3	0	1
IDAHO	2	4	3	0	0	0	0	1	0	2
OREGON	4	5	5	1	0	0	0	0	0	3
WASHINGTON	3	7	5	0	0	0	0	0	0	5
NATIONAL TOTALS	242	294	189	14	1	6	0	11	0	290

Table B.5

DISTRIBUTION OF WWTP SAMPLE BY TREATMENT PROCESS

	STABILIZATION PONDS	AERATED LAGOONS	ACTIVATED SLUDGE	TRICKLING FILTER	OTHER	TOTALS
REGION 01	1	0	20	1	2	24
CONNECTICUT	0	0	2	1	1	4
MAINE	0	0	3	0	1	4
MASSACHUSETTS	0	0	5	0	0	5
NEW HAMPSHIRE	1	0	4	0	0	5
RHODE ISLAND	0	0	2	0	0	2
VERMONT	0	0	4	0	0	4
REGION 02	0	0	29	6	7	42
NEW JERSEY	0	0	10	4	0	14
NEW YORK	0	0	19	2	7	28
PUERTO RICO	0	0	0	0	0	0
VIRGIN ISLANDS	0	0	0	0	0	0
REGION 03	1	3	55	9	3	72
DELAWARE	0	0	2	0	0	2
WASHINGTON DC	0	0	0	0	0	0
MARYLAND	1	0	13	1	0	15
PENNSYLVANIA	0	2	25	4	1	32
VIRGINIA	0	1	13	3	1	19
WEST VIRGINIA	0	0	2	1	1	4
REGION 04	1	0	14	2	1	19
ALABAMA	1	0	2	0	0	3
FLORIDA	0	0	2	1	0	4
GEORGIA	0	0	2	0	0	2
KENTUCKY	0	0	0	0	0	0
MISSISSIPPI	0	0	0	0	0	0
NORTH CAROLINA	0	0	4	1	1	6
SOUTH CAROLINA	0	0	1	0	0	1
TENNESSEE	0	0	3	0	0	3
REGION 05	7	6	128	30	20	198
ILLINOIS	0	2	39	14	2	59
INDIANA	1	1	32	2	3	40
MICHIGAN	1	1	11	3	6	23
MINNESOTA	3	2	9	2	1	17
OHIO	2	0	24	5	4	38
WISCONSIN	0	0	13	4	4	21
REGION 06	3	0	20	7	2	36
ARKANSAS	0	0	1	3	1	5
LOUISIANA	0	0	6	0	0	7
NEW MEXICO	0	0	1	1	1	3
OKLAHOMA	3	0	4	1	0	8
TEXAS	0	0	8	2	0	13

TABLE B.5 (Continued)

DISTRIBUTION OF WWTP SAMPLE
BY TREATMENT PROCESS

	STABILIZATION PONDS	AERATED LAGOONS	ACTIVATED SLUDGE	TRICKLING FILTER	OTHER	TOTALS
REGION 07	3	0	10	4	3	23
IOWA	1	0	2	1	3	7
KANSAS	1	0	2	1	0	4
MISSOURI	1	0	3	0	0	6
NEBRASKA	0	0	3	2	0	6
REGION 08	12	1	11	3	3	30
COLORADO	0	0	4	1	1	6
MONTANA	1	0	4	0	1	6
NORTH DAKOTA	3	1	1	0	0	5
SOUTH DAKOTA	4	0	0	0	0	4
UTAH	2	0	1	2	1	6
WYOMING	2	0	1	0	0	3
REGION 09	4	7	30	10	8	62
ARIZONA	0	1	4	0	1	6
CALIFORNIA	2	2	23	7	6	41
HAWAII	0	0	3	0	0	5
NEVADA	2	4	0	3	0	9
AMERICAN SAMOA	0	0	0	0	0	0
GUAM	0	0	0	0	1	1
TRUST TERR.	0	0	0	0	0	0
REGION 10	2	1	16	4	5	30
ALASKA	0	0	2	1	2	5
IDAHO	1	0	3	1	1	6
OREGON	0	0	6	2	1	9
WASHINGTON	1	1	5	0	1	10
NATIONAL TOTALS	34	18	333	76	54	536

APPENDIX C

COST INDEXING

APPENDIX C

COST INDEXING

C.1 REQUIREMENTS

Construction bid data employed in developing cost relationships presented in this report originated across a wide spectrum of time and location. Bid dates ranged from second quarter 1973 to second quarter 1977 and locations varied from Alaska to Puerto Rico. Data included Step I and Step II grant costs, non-construction item costs for administrative, legal and contingency expenses, and lump-sum costs for treatment plant construction unit processes and construction components. Because of these variations it was necessary to devise a system for referencing costs to a common dollar base for the purposes of data analysis.

For the purposes of this study several indexing tools were considered. Criteria for selection of the most appropriate method included the following:

1. National Scope - The data base included facilities nationwide therefore the indexing method had to apply to all geographical areas of the country.

2. Sufficient Time Span - Bids to be updated were, in some cases, four years old. The indices must be applicable to each quarter from 1973 to the present.

3. Treatment Plant Oriented - The mix of material and labor components had to be reflective of that typical to wastewater treatment facilities.

4. Commonly Accepted and Available - Due to the possibility of future use of this study as well as its potential for updating, the indexing method had to be available to and accepted by the user community.

C.2 COST INDEXING SYSTEMS INVESTIGATED

There are a number of cost indexing systems in existence, each directed at the needs of a specific user. Some, such as the Consumer Price Index are general in nature and applicable to a variety of products and services. Others, like the Federal Highway Index, serve specific estimating needs. Generally, input to the development of each index consists of a mix of material and labor costs. The composition of this mix determines the relevance of a given index to a particular construction estimating requirement.

Using the criteria above, several cost indexing methods were investigated for use in this study including the Engineering News Record (ENR) Building Cost Index, the ENR Construction Cost Index and Chemical Plant Cost Index, the Bureau of Reclamation Index, the EPA Treatment Plant Indices, and two contractor cost indices.

Since analysis of cost indexing techniques was of secondary concern for this study, some reliance was placed on previous efforts at index comparison, particularly in comparing the indices records. Of interest in this regard was the publication "Comparison of Construction Cost Indexes" of March 1976 by the EPA. This report investigated the response of each of several indices during the late 1960's and inflation/deflation period of the 1970's. Upon investigation, it was decided that the two EPA-developed indices for treatment plants were most appropriate and would be employed for this study. These are the Large City Advanced Treatment (LCAT) Index and the Small City Conventional Treatment (SCCT) Index.

C.3 THE EPA TREATMENT PLANT INDICES

C.3.1 Large City Advanced Treatment Index

The LCAT Index is based on a model 50 MGD treatment plant consisting of bar screens, grit chambers, primary clarification, conventional activated sludge, lime clarification, multi-media gravity filtration, chlorination, gravity thickening of sludge, vacuum filtration and multiple hearth incineration. Indices for 25 large cities were developed using a Kansas City Index of 100 in the third quarter of 1973 as a base.

C.3.2 Small City Conventional Treatment Index

The SCCT index uses a 5.0 MGD activated sludge facility as a model. It includes the same processes as the LCAT model excluding those designed to produce greater than secondary treatment, namely, lime clarification and multi-media gravity filtration. Indices are maintained for 25 small cities nationwide. The base city for the SCCT index is St. Joseph, Missouri with an index of 100 in the third quarter 1973.

C.3.3 Index Composition

From the model designs each plant was broken down into cost components, the mix of these components being the fundamental bases of the indices. Based on second quarter 1975 costs the LCAT mix of cost components was found to be: equipment, 17.2% (of total cost); civil material and labor, 35.4%; piping material and labor, 10.3%; electrical material and labor, 2.7%; construction overhead, 22.5%; and miscellaneous, 12%.

This component mix and a similar mix for the SCCT index plant seemed to reflect the ratio of components of facilities reviewed for this study better than other indices considered for use. The LCAT and SCCT Indices also include profit adjustment and productivity factors in an attempt to define price increases due to supplier backlog and variations in labor productivity, respectively.

EPA indices are updated quarterly and published in the Engineering News Record periodically. Tables C.1 and C.2 tabulate the SCCT and LCAT indices from their origination to second quarter, 1977. Values listed in these tables are final values and may in some cases vary slightly from preliminary calculations published in the Engineering News Record.

The Alaska, Hawaii and Guam indices listed on these tables were not published by EPA but were estimated as outlined in the following paragraphs. All cost relationships presented in this report have been updated to second quarter 1977 dollars.

C.4 ANCHORAGE, HONOLULU AND GUAM INDICES

Because construction bid information was collected for facilities in Alaska, Hawaii and Guam, indices were required to update those costs. The indices listed in Tables C.1 and C.2 for Alaska, Hawaii and Guam were developed for this purpose using the following procedure:

1. From the data bank of the 1976 Needs Survey, including over 19,000 treatment facilities, multipliers were developed for Alaska, Hawaii and Guam for newly constructed facilities. These multipliers are a ratio of the average cost of construction in the particular state to the national average cost of construction for similar facilities. Only costs based on engineers' estimates and cost of previous comparable construction were used for this analysis.

2. The 25 city index average for each quarter was then multiplied by the appropriate Alaska, Hawaii or Guam multiplier from above yielding a quarterly index for these three areas.

The Alaska and Hawaii indices were grouped with the SCCT indices since facilities sampled in these states fell into that category. The same rationale was used to place Guam in the LCAT group. Criteria for classification of treatment plants into LCAT or SCCT categories are given below.

C.5 USE OF THE EPA TREATMENT PLANT INDICES

C.5.1 LCAT-SCCT Classification

Most facilities were readily placed in either the SCCT or LCAT group, but some did not fall easily into either. Since the mix of component costs for treatment plants is more sensitive to process equipment variation than size the SCCT index was applied to all conventional treatment facilities and the LCAT index to all advanced treatment facilities. An exception to this rule was the case of lagoons, classified in all instances as small, conventional facilities.

C.5.2 City Influence Classification

Applying the appropriate quarterly index to a construction bid required the determination of which EPA index city most influenced the contract prices. The areas of influence illustrated by Map C.1 and Map C.2 are the result of application of the following criteria:

1. County boundaries were followed without exception.
2. State boundaries were followed where more definitive information was unavailable.

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3. Bureau of Labor Statistics Information was used to draw boundaries where such information was available.

C.5.3 BLS Data

Due to the fact that labor is generally the largest single cost component for a wastewater treatment plant an effort was made to define boundaries on Maps C.1 and C.2 based on Department of Labor, Bureau of Labor Statistics data. The Bureau regularly collects and tabulates wage rates for a variety of construction skills for 102 cities nationwide. From these tabulations a combined rate for carpenters, masons and building laborers was derived for 15 quarters dating from third quarter 1973 to first quarter 1977. These three skills were chosen because they correspond to the labor skills that comprise the labor component of the EPA indices. Next, the 15 quarters of record for each of the 102 BLS cities were statistically correlated to the labor component history of each of the EPA index cities yielding a correlation coefficient representing the similarity of that city's labor costs to each EPA city. These correlations were then used to define areas of influence for LCAT and SCCT index cities. For example, the correlations of the BLS cities, Chattanooga, Nashville and Knoxville with the LCAT city of Birmingham were all much higher than their correlations with the LCAT city of Cincinnati. Therefore, Birmingham's influence boundary was drawn to include Tennessee. Similarly, the wage rate histories of the Atlanta and Miami Standard Metropolitan Statistical Areas (SMSA) were so radically different than those of the closest BLS city histories that the areas of influence for those two cities include only the respective SMSA's.

C.6 COMMON-BASE COST CONVERSIONS

Using Maps C.1 and C.2 along with Tables C.1 and C.2, construction bid data for a given location and date may be converted to a common dollar base for development of a national average cost relationship. An example of this might be a bid cost of X dollars in January, 1975 for a 5.0 MGD conventional plant in Cheyenne, Wyoming. Classifying this facility into the Small City Conventional Plant (SCCT) category, the influence city is found from Map C.1 to be Casper, Wyoming. From Table C.1 the first quarter 1975 index for Casper is 102. To convert the cost to second quarter 1977 dollars, X should be multiplied by 117/102 or 1.15. Conversely, cost values taken from national average cost curves must be multiplied by the ratio of the index for the appropriate city and the national average index for the same quarter to arrive at a cost estimate based on the economy of the specific city.

TABLE C.1

EPA SMALL CITY CONVENTIONAL TREATMENT (SCCT) INDEX

CITY NO.	CITY NAME	1973		1974				1975				1976				1977	
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
1	Bakersfield	105	101	103	115	122	123	121	118	119	119	127	128	132	134	138	138
2	Bismarck	81	80	84	92	97	99	96	94	98	100	102	104	107	108	108	108
3	Burlington, Vt	92	92	94	101	106	108	104	101	101	102	104	104	105	107	108	108
4	Casper	84	85	88	97	104	105	102	101	101	105	108	108	114	115	115	117
5	Charlestown, SC	58	58	61	66	72	76	72	69	77	77	74	77	77	81	82	83
6	Cumberland, Md.	110	109	112	120	127	128	126	126	126	128	129	130	134	135	138	143
7	Duluth	95	94	96	106	112	113	109	107	109	109	114	116	118	119	124	128
8	Eugene	102	104	107	116	123	124	121	118	119	122	130	137	137	139	141	141
9	Gainesville	80	80	83	91	97	102	99	98	97	98	100	101	101	102	104	107
10	Green Bay	103	103	107	113	119	122	123	119	119	121	123	122	124	125	131	131
11	Harrisburg	102	105	109	113	120	122	119	122	126	129	132	135	138	139	138	144
12	Las Vegas	102	101	103	113	119	124	121	119	126	127	129	130	136	140	142	142
13	Mobile	92	91	92	103	111	123	121	117	118	120	118	119	120	121	127	127
14	Muncie	95	96	98	108	114	114	112	111	112	113	114	117	120	124	123	127
15	Pocatello, Id.	84	88	90	97	104	105	103	104	105	108	108	110	112	114	115	116
16	Pueblo	87	87	89	97	104	104	105	98	98	99	107	110	113	114	115	119
17	Rapid City	79	79	81	89	97	98	94	92	94	95	99	102	103	105	105	106
18	Roanoke	87	80	83	90	97	108	106	103	102	105	110	114	115	116	116	117
19	Saginaw	105	104	104	111	118	120	118	115	117	118	120	120	122	123	127	128
20	St. Joseph	100	102	106	116	122	119	115	113	113	113	116	117	120	120	124	125
21	Sioux City	90	90	95	103	108	108	105	107	107	107	113	117	118	120	120	130
22	Syracuse	124	126	127	136	141	140	137	137	138	139	142	143	146	148	147	150
23	Tulsa	81	82	85	97	102	101	99	96	97	98	101	103	104	108	109	111
24	Waco	74	73	77	84	90	92	89	87	87	88	90	91	91	92	97	99
25	Wheeling	105	106	108	116	122	122	120	118	121	122	122	124	125	126	129	132
26	Alaska	254	254	261	283	301	306	300	294	298	302	310	315	321	326	331	337
27	Hawaii	131	131	134	146	155	158	154	152	154	156	160	162	165	168	170	173
	25 City Average	93	93	95	104	110	112	109	108	109	110	113	115	119	119	121	123

TABLE C.2

EPA LARGE CITY ADVANCED TREATMENT (LCAT) INDICES

CITY NO.	CITY NAME	1973		1974				1975				1976				1977	
		3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
1	Atlanta	87	87	91	97	105	107	103	98	99	100	102	103	106	106	109	110
2	Baltimore	106	106	110	114	122	124	120	120	120	122	125	132	134	134	134	134
3	Birmingham	84	83	89	94	101	102	99	95	98	99	101	101	102	103	105	107
4	Boston	118	118	121	129	136	139	135	135	135	136	140	141	143	145	146	149
5	Charlotte	57	58	62	68	75	76	73	68	74	75	76	77	79	82	83	83
6	Chicago	121	121	126	135	143	144	141	137	138	140	144	146	152	153	155	158
7	Cincinnati	105	105	108	119	127	126	123	121	123	124	126	127	130	131	132	134
8	Cleveland	113	113	116	127	134	132	129	126	128	129	132	133	139	140	141	147
9	Dallas	82	83	87	96	103	102	98	93	94	95	99	104	105	107	108	111
10	Denver	87	88	91	99	107	108	105	101	105	105	108	111	113	114	115	120
11	Detroit	109	111	111	124	132	127	125	120	120	121	130	130	132	133	140	145
12	Houston	83	84	89	95	102	107	103	103	103	104	106	112	113	114	114	119
13	Kansas City	100	100	104	115	124	125	120	118	119	120	122	126	128	129	129	133
14	Los Angeles	104	103	107	113	121	127	125	121	126	126	130	133	137	138	141	141
15	Miami	92	93	96	103	110	111	108	104	105	106	108	109	110	111	112	113
16	Milwaukee	102	102	106	112	120	125	123	123	123	125	126	129	131	133	134	138
17	Minneapolis	96	96	99	107	113	115	112	108	108	109	116	120	122	123	123	127
18	New Orleans	94	92	96	102	112	118	113	110	110	113	116	120	121	123	124	128
19	New York	139	138	141	148	154	161	157	152	158	160	164	163	168	169	171	175
20	Philadelphia	122	122	125	141	148	144	140	140	141	142	146	152	154	155	155	159
21	Pittsburg	108	108	111	123	131	130	128	125	124	126	127	129	130	131	135	138
22	St. Louis	117	117	123	130	143	140	136	136	138	139	141	147	149	150	151	153
23	San Francisco	111	110	114	121	128	134	130	128	133	134	138	141	151	152	153	153
24	Seattle	100	101	105	114	123	124	121	120	123	124	128	133	135	137	138	139
25	Trenton	115	114	117	125	134	135	130	127	129	130	133	136	140	141	140	144
26	Guam	116	115	119	129	137	140	137	134	136	138	141	144	146	148	151	154
	25 City Average	102	102	106	114	122	123	120	112	119	120	123	126	129	130	132	134

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